V605 v.66 pt.2

POWER

Volume 66 New York, October 4, 1927 Number 14

The Value of Reading

THE actual experience of the average man is comprised within narrow limits.

Most of the things that he knows, he does not find out for himself, but learns from others.

And the general way of learning from others is by reading.

Few have opportunities of meeting a large number of people, especially people who can and do tell interesting and useful things; but the printing press and the postal service make it possible for everybody who can read to share the thinking and experience of the leaders of thought, research and achievement all over the world.

Try it on yourself:

Of the thousands of places in the world of which you know something, how many have you actually visited? What you know of the rest you got by reading or hearing about them—counting the pictures that you have seen of them in with the reading.

There are many mathematical and physical facts that are obvious and demonstrable when once they are known—but people usually learn them as pupils, out of books.

You have an idea of what many power plants besides your own are like, what their practices are and what results they are getting.

How many of them have you actually visited, and of how many did you learn what you know by reading about them?

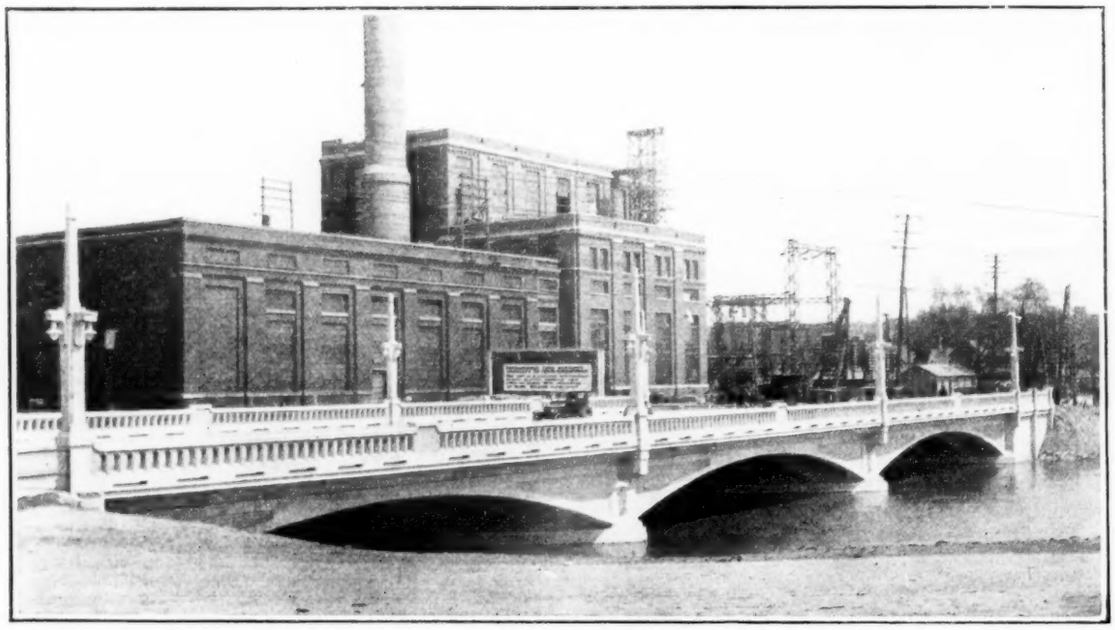
You use in your plant different kinds of apparatus and supplies. Some of them you select yourself.

How did you first learn that there were such things, particularly adapted to your conditions?

You know a great deal about the principles of operation and the detailed mechanism of many appliances and pieces of apparatus the insides of which you have never seen. You have read about them.

Reading maketh a full man. Let not your mind be empty.

F. R. Low



Unit Coal Pulverizers for 20,000-Kilowatt Single-Unit Plant

By Paul A. Vickers

ON THE first day of June, less than eight months after the first concrete was poured, the 20,000-kw. steam generating station of the Consumers Power Co. at Kalamazoo, Mich., was put into service. The rapid growth of the load on the company's system during the last year made it urgent that all work progress as rapidly as possible. In view of this work was carried on twenty-four hours a day during certain periods and lumnite cement was used whenever subsequent construction could be speeded up or the length of time required for protection from freezing weather could be reduced thereby.

While presenting little that is unique in design or construction, this plant is of interest as an example of the present-day tendency toward the use of pulverized fuel, water-cooled furnace walls, and substitution of air preheaters for economizers. An outstanding feature is the simplified and compact arrangement of the boiler room, made evident in the sectional elevation, Fig. 3. Limited space on the site made it necessary to conserve floor area and carry the boiler room to an elevation exceeding 100 ft. from basement floor to roof. Unit pulverizers on the basement floor feed directly to the boiler furnaces. The air preheaters and the forced- and induced-draft fans are above the boilers, and at the rear are the closed bleeder heaters, with the pumps and the evaporator, arranged in vertical order to best suit the space available.

Situated near the new concrete memorial bridge over the Kalamazoo River at East Avenue, the station joins an old plant containing a 3,000-kw. unit which is kept as stand-by capacity. A portion of the old building is used to house the switchboard and the main bus and oil circuit-breaker structures. The new building is 100 ft. wide and has an average length of 110 ft. It is of brick with precast concrete trim, and matches the existing structure both in material and design. Because of the limited ground space available, the present installation is all that is planned for this location.

Coal for the plant is received on parallel sidings on the north

IN THE KALAMAZOO steam plant of the Consumers Power Co., three 15,360-sq.ft. boilers are each equipped with two unit mills, and water walls with flexible connections to drum. Boilers 18 tubes high in main bank and plate type preheaters are preferred to economizers. Entire arrangement is unusually simple and compact. Auxiliaries are electric-driven and three-stage bleeding to heat the feed water.

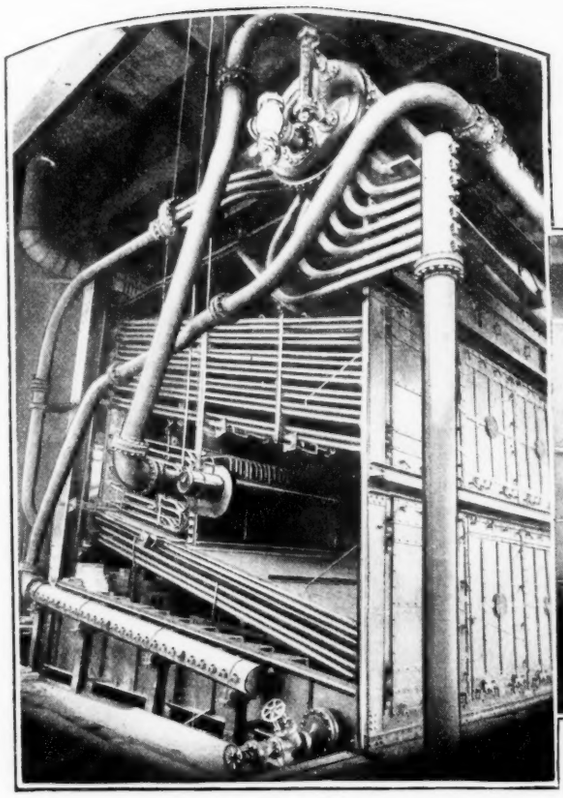


Fig. 1—Side of boiler above furnace showing headers and piping for water walls and superheater connections

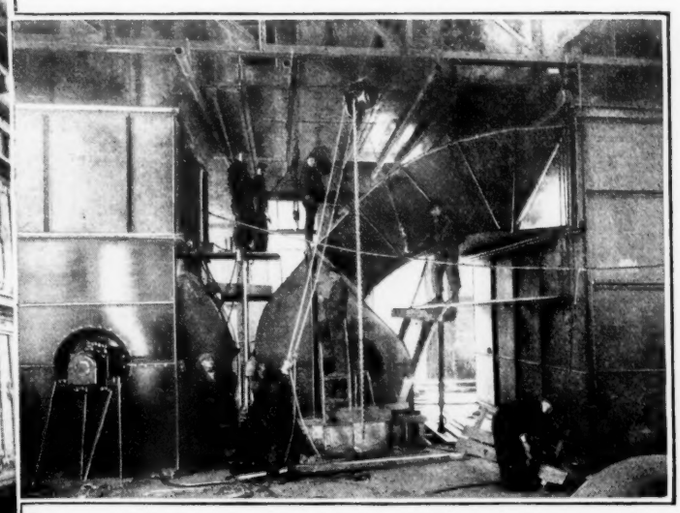
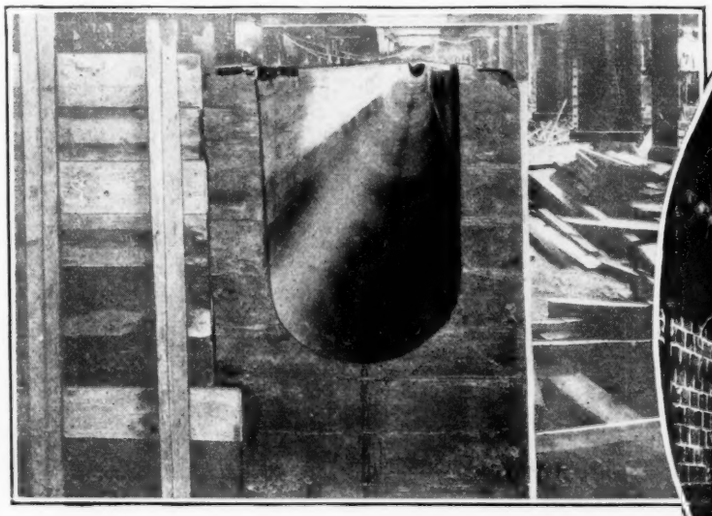


Fig. 2—Induced-draft fan having 48-in. diameter wheel at left, and at right forced-draft fan delivering to preheater

Fig. 3—Below, Looking up concrete ash sluice from ash sump pit. Internal width 26 in. and slope 1 ft. in 60 ft.



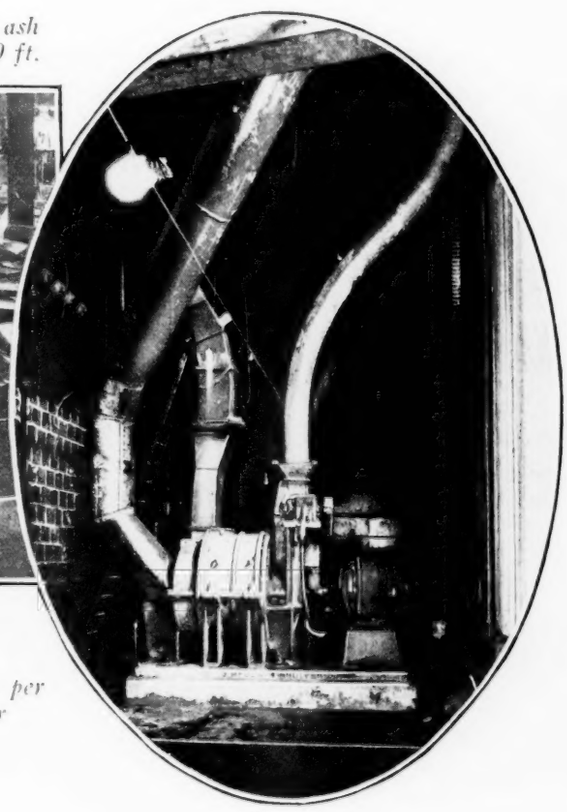


Fig. 4—Right, Motor-driven unit pulverizer, two per boiler, each capable of delivering 4 tons per hour

and south sides of the storage yard and deposited in two 14x14-ft. steel hoppers, one under each track. From each hopper it is passed by a reciprocating plate feeder to a rigid-hammer crusher which discharges to a belt conveyor. Coal of $1\frac{1}{4}$-in. size or under can be bypassed around the crusher and deposited directly on the conveyor. From the conveyor the coal is carried over a magnetic separator to an elevator which delivers to a distributing belt conveyor, thence over a weightometer to one of the three 150-ton bunkers. The entire coal-handling equipment is of sufficient capacity to permit complete filling of the three bunkers in a nine-hour day.

From the bunkers the crushed coal passes directly down to the pulverizers, of which there are two per boiler, or a total of six. These are unit mills with a capacity of 8,000 lb. per hour per mill for Switzer coal. As they are nominally rated at 10,000 lb., it is probable that they can exceed the guaranteed capacity even under difficult coal conditions. Each pair of mills feeds a common line which in turn supplies the four burners of the corresponding boiler.

After a thorough study it was decided to omit economizers in the plant and to substitute therefor increased surface in the boilers and air preheaters. Although a combination of economizers and air preheaters would have shown the greater reduction in flue-gas temperature, the maximum over-all economy was found to result from the layout as installed. The boiler height was increased to 18 tubes in the main bank and $\frac{1}{2}$x$\frac{1}{2}$-in. plate-type air preheaters, each with a heating surface of 21,600 sq.ft., were installed above the boilers. For a flue-gas temperature leaving the preheater of about 300 deg. F., the secondary air will be raised from 80 to 450 deg. The forced-draft fans supplying this air are of the double-inlet type capable of handling 55,000 cu.ft. of 80-deg. air per minute against a static head of 8.7 in. Induced-draft fans will handle 100,000 cu.ft. of 380-deg. gas per minute against a head of 8.5 in.

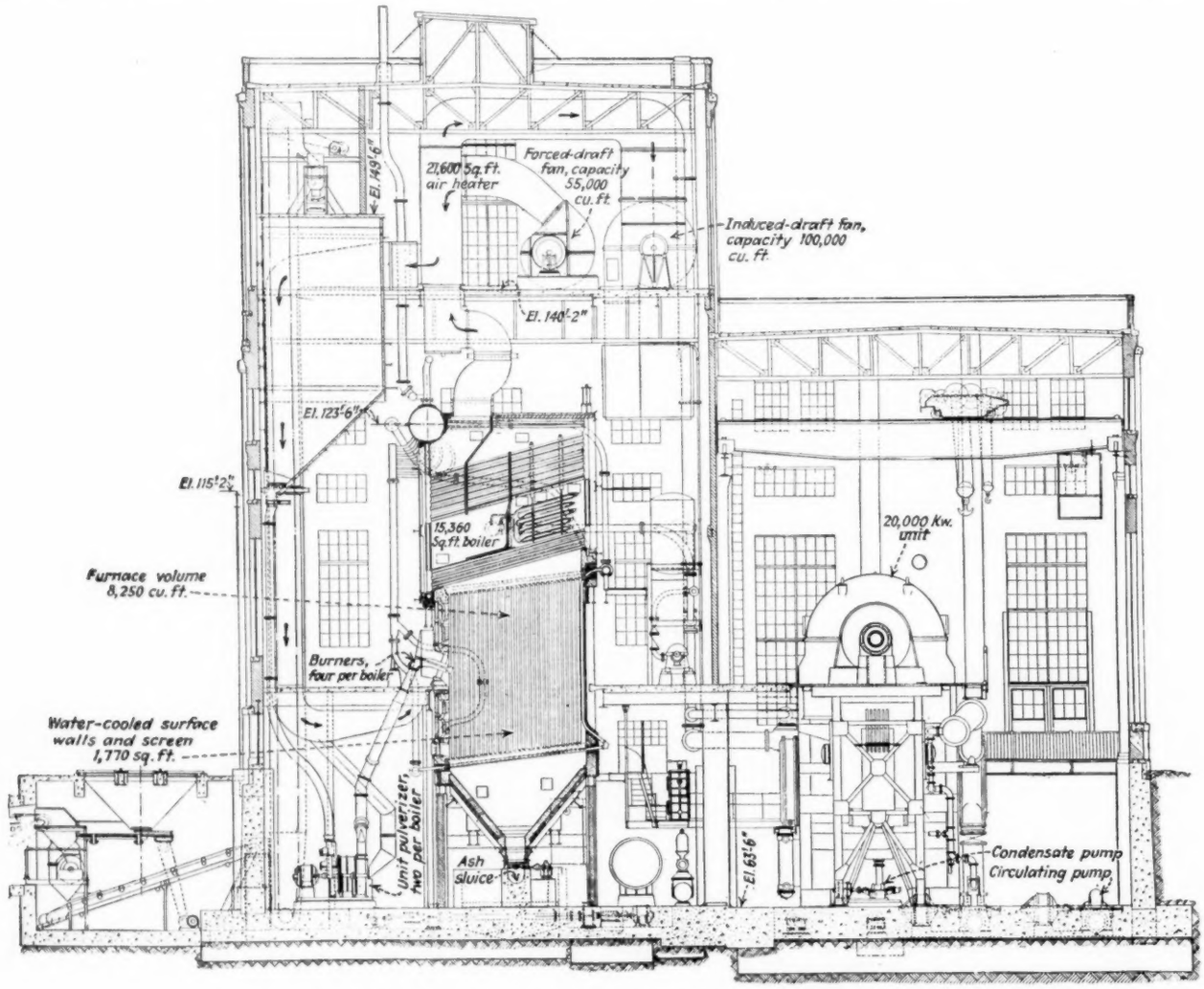


Fig. 5—Typical cross-section through entire plant

The plant contains three 15,360-sq.ft. boilers of the sectional-header cross-drum type designed for a working pressure of 400 lb. Interdeck superheaters give a superheat of 250 deg. when the boiler is supplying 120,000 lb. of steam per hour. Additional heating surface of 1,770 sq.ft. is provided by fin-tube back and side walls and by a water screen across the ashpit. Connections were made that provide complete circulation of water from the boiler drum through the walls and back again to the drum. A common line leaves the boiler drum at each end and supplies water to the two circuits, one through the water screen and the rear wall and the other through the side

walls. These two circuits then return to the drum through the rear and front, respectively. The flexible bends connecting the risers to the drum are shown in Fig. 1.

There are four burners for each boiler, set horizontally in a single row in the front wall. Expansion of the flame is accomplished by the use of cone-shaped deflectors at the outlet of the primary air pipe, and the swirling motion given by the vanes of the secondary air inlet surrounding the primary element provides thorough diffusion.

Ash falls to a refractory-lined steel hopper and into the ash sluice through motor-operated slide gates. From the sluice the ash is pumped through an 8-in. pipe of specially resistant cast iron to a large area of low ground just across the Michigan Central Railroad tracks to the north. Thus the problem of ash disposal is solved for an indefinite period. The ash discharge line passes through the concrete tunnel connecting the north and south track coal hoppers, and on through a 30-in. welded steel culvert extending from the tunnel to the land beyond the railroad. The method employed in laying this culvert under the railroad is of interest. A 10-ft. section of pipe was forced into the earth and gravel by means of a 30-ton hydraulic jack. Additional 10-ft. sections were welded on as needed until the culvert had been forced through the entire width of 40 ft. under the railroad. The possibility of any settlement or the necessity of cribbing in a tunnel was thus avoided.

Three-Stage Bleeding to Heat Feed Water

Owing to the fact that the station is expected to operate at the relatively high annual load factor of 65 per cent, a greater investment in feed-water heating was justified than with plants operating under less favorable conditions. The fact, too, that it was designed for only a single unit made possible a feed-water cycle offering maximum heat economy with little added complication. The turbine is bled at the fourth, seventh and eleventh stages, supplying steam for the evaporator and the three feed-water heaters. The evaporator and one high-pressure heater are supplied by the fourth, the second high-pressure heater by the seventh and the low-pressure heater by the eleventh stage. The capacity of the evaporator is sufficient to provide for 5 per cent makeup water

PRINCIPAL MECHANICAL EQUIPMENT OF KALAMAZOO STEAM PLANT, CONSUMERS POWER CO.

BOILERS AND AUXILIARIES

Boilers, cross-drums, three	Springfield Boiler Co.
Surface, sq.ft.	15,360
Pressure, lb. gage	400
Av. temp. feed-water to boiler, deg. F.	300
Furnace volume, cu.ft.	8,250
Water-cooled walls, fin tube; water screen	Combustion Eng. Corp.
Surface, walls and screen, sq.ft.	1,770
Superheater, Elesco, interdeck	Superheater Co.
Soot blowers	The Bayer Co.
Burners, 4 per boiler Ba ley-Tenney	Fuller-Lehigh Co.
Primary air line diameter, in.	12
Pulverizers, Simplex unit mills, two per boiler	Furnace Eng. Co.
Capacity of each with Switzer Coal, lb. per hr	8,000
Crushers, one, 50 tons per hour	Jeffrey Mfg. Co.
Fans, forced-draft, three	Clarage Fan Co.
Capacity, cu.ft. per min. at 8.7 in. stat. press.	55,000
Drive, motor, hp	125
Fans, induced-draft, three	Clarage Fan Co.
Capacity, cu.ft. per min. at 8.5 in. stat. press.	100,000
Drive, motor, hp	250
Air preheaters, three, ½ x ½-in. plate type	Combustion Eng. Corp.
Surface, sq.ft.	21,600
Av. temp. inlet air, deg. F.	80
Av. temp. outlet air, deg. F.	450

FEED-WATER HEATERS AND EVAPORATOR

Heaters, closed, three	Griscom-Russell Co.
Capacity, 11th stage, 83 to 154 deg., lb. per hr	240,000
Capacity, 7th stage, 154 to 246 deg., lb. per hr	240,000
Capacity, 4th stage, 246 to 323 deg., lb. per hr.	240,000
Evaporator, one, Reilly coil-type	Griscom-Russell Co.
Capacity, lb. per hr	12,000
Hot-water storage heater	Griscom-Russell Co.

PUMPS

Boiler feed, centrifugal, three	Pennsylvania Pump & Comp. Co.
Capacity, gal. per min.	600
Drive of two pumps, motor, hp.	300
Drive of one pump, turbine, hp.	300
Service pump, reciprocating, one, 14 x 17 x 20-in.	American Steam Pump Co.
Service pumps, cent., one 800 g.p.m.; one 400 g.p.m.	American Steam Pump Co.
Deep-well pumps, one, 350 g.p.m.	Worthington Pump & Mch. Corp.
Air compressor, 10 x 9-in., 169 cu.ft. per min.	Pennsylvania Pump & Comp. Co.

COAL AND ASH HANDLING

Plate feeders, reciprocating, two	Jeffrey Mfg. Co.
Belt conveyors, 30-in., 24-in. and 18-in.	Jeffrey Mfg. Co.
Bucket elevator	Jeffrey Mfg. Co.
Magnetic separator	Dings Magnetic Separator Co.
Weightometer	Merrick Scale Mfg. Co.
Storage coal crane, traveling, 4 ton	Manning, Maxwell & Moore, Inc.
Ash sluicing system	Beaumont Mfg. Co.

GENERATING UNIT

Manufacturer	General Electric Co.
Turbine, 14-stage, r.p.m.	1,800
Pressure at turbine throttle lb. gage	375
Steam temperature, deg. F.	692
Steam bled from 3 points, av. per cent	20
Generator, 3-ph., 60-cycle, 5,000-v; kw. at 80 per cent p.f.	20,000
Exciter, direct connected, 135-kw., 250-v.; pilot exciter 2-kw., 115-v.	

SURFACE CONDENSER

Two-pass, divided water box	Foster Wheeler Corp.
Tube surface in main shell, sq.ft.	23,500
Surface in two external fin-tube coolers, sq.ft.	1,500
Tubes	Admiralty metal, 1 in. O.D.
Circulating pumps, two, gal. per min.	15,500
Drive, motor, hp	125
Condensate pumps, two, gal. per min.	600
Drive, motor, hp.	40
Air pumps, twin, steam-jet with surface inter- and after-condenser. Capacity each element, cu.ft. free air per min.	20

MISCELLANEOUS EQUIPMENT

Boiler setting masonry	M. H. Detrick Co.
Travelling screens, two	Chain Belt Co.
Crane, turbine room, 60-ton	Cleveland Crane & Eng. Co.
Damper control	Carrick Eng. Co.
Desuperheater	Croll-Reynolds Eng. Co.
Elevators	Holister-Whitney Co.
High-temperature insulating material	Philip Carey Co.
Low-temperature insulating material	S. P. Conkling
Venturi meters	Builders Iron Foundry
Instruments	Bailey Meter Co., Foxboro Co., Inc.
High-pressure piping	Murray W. Sales & Co.
Low-pressure piping	Pittsburgh Piping & Equip. Co.

VALVES

Gate and globe, high-pressure	Lunkenheimer Co.; Chapman Valve Mfg. Co.
Gate and globe, low-pressure	Chapman Valve Mfg. Co; Crane Co.
Turbine bleeder check valves	Schutte & Koerting Co.
Atmospheric relief valve, multiport	Cochrane Corp.
Boiler-stop check valves	Elliott Co.; Lagonda Mfg. Co.
Boiler-feed check valves	Edward Valve & Mfg. Co.
Blowoff valves	Edward Valve & Mfg. Co.
Safety valves, consolidated	Manning, Maxwell & Moore, Inc.
Boiler-feed regulators, Copes	Northern Equipment Co.
Excess pressure regulators	S-C Regulator Mfg. Co.

with 240,000 lb. of steam per hour going to the turbine. The vapor from the evaporator is condensed in the seventh-stage feed-water heater.

The piping layout presents nothing unusual. The main steam header is designed for 400-lb. service, using seamless tubing and 400-lb. A.E.S.C. flanges, and the boiler-feed mains for 600 lb., with 600-lb. A.E.S.C. flanges. Feed-water control is provided by feed-water regulators and differential pressure regulators at each boiler. The only motor-operated valves in the plant are the two on the 24-in. discharge lines from the circulating pumps.

Salt-glazed brick in brown and buff are used for the walls of the boiler and turbine rooms. The floors of the turbine room and the entrance are of square red tile with black joints. The prime mover is a 14-stage turbine rated at 20,000 kw., 80 per cent power factor, equipped for three-stage bleeding. The turbine exhausts into a two-pass divided-water-box type of surface condenser having 25,000 sq.ft. of total cooling surface. The condenser is bolted directly to the exhaust casing of the turbine and is mounted on spring supports. Of the total cooling surface 23,500 sq.ft. is in the condenser shell and 1,500 sq.ft. in two external coolers furnished with finned tubes. The condenser is served by two circulating pumps, two condensate pumps and a two-stage steam-jet air pump equipped with surface-type inter- and after-condenser. Instead of the usual heavy cast-iron pipe and fittings the circulating water intake and discharge line is built up of welded $\frac{1}{4}$-in. steel plate. Condensing water is taken from the Kalamazoo River through a 60-in. line of precast concrete pipe. The intake structure contains two traveling screens housed in a superstructure harmonizing with the main plant.

All plant auxiliaries are motor driven with the exception of one turbine-driven boiler feed pump for stand-by service and a house-service reciprocating steam pump which is kept floating on the line.

Coal storage of 6,000 tons is provided between the two sidings north of the plant, the coal being deposited and reclaimed by a 4-ton traveling crane.

Electrical System

The present electrical layout of the plant is the result of a complete reconstruction of the equipment that served the old plant, the 140-kv. lines, and the distribution substations located here. This work was started over two years ago, and the installation of the present equipment will complete the major work to be done. Provision is made for the addition of future distribution circuits as needed. The reconstruction consisted in replacing the old bus with a new 5,000-volt ring bus and complete concrete bus and switching structures.

The ring bus is sectionalized by a 7,500-volt oil circuit-breaker and by bus disconnects. The layout is arranged so that in case of a storm all the local load can be taken off and carried by the plant and still keep the transmission lines tied together.

Rated at 20,000 kw. at 80 per cent power factor, the generator delivers three-phase 60-cycle currents at 5,000 volts. It has a direct-connected exciter with small pilot exciter for more stable operation. Station power is taken from the ring bus through three 750-kva., 5,000-480-volt transformers. The two motor-driven boiler-feed pumps and the two circulating pumps are supplied directly from the 480-volt bus through oil circuit breakers, while similar breakers serve groups of the smaller motors. Two 10-kw. motor-generator sets supply the six direct-current pulverizer feeder motors and the magnetic separators. Each of these sets is sufficient to carry the load and is so arranged that it will come on the line automatically if the other fails. As further protection they are on different motor-group buses. This practice of putting similar units in different groups is also followed for the condensate pumps and the house-service pumps.

Individual control for the majority of the motors in the various groups is provided by combined switch and circuit breakers. In all cases the controls are at the motors with push-button stop switches for the more important ones on the boiler panels.

A few words regarding the construction methods employed may be of interest. It has been stated that cement of high early strength was used in certain places to speed up construction. The concrete plant consisted of a one-yard mixer with a batch-measuring plant and inundator. The water-cement ratio was closely regulated, and several samples were taken from each major pour. In all, about sixty cylinders were broken and the results of these tests showed the value of the attention paid to this part of the work. In a mix designed for an average strength of 2,500 lb. and a minimum of 2,000 lb., the tests showed an average of about 2,800 lb. In only two cases did the cylinders break as low as 2,000 lb., and the cause of this low figure could be readily determined by an examination of the individual cylinders.

The construction of the plant was carried out by the Consumers Power Co. It was designed by the Commonwealth Power Corporation of Michigan, William W. Tefft, chief engineer.

Effect of Sulphur in Fuel

EXPERIMENTS were made during the winter of 1922-23 by Mr. Kreis, of the Continental Motor Company, and S. H. Diggs, Standard Oil Company of Indiana, using a Jordan engine fitted with new wristpins, pistons and rings for each experiment with the idea of discovering the effects of sulphur in gasoline upon the running parts. The engine was run one hour and allowed to stand idle one hour. All work was done when the temperature was below freezing, though not very cold.

Each test represented from 60 to 75 hours' running time. Results showed that when using a gasoline of 0.040 per cent sulphur there was no corrosion of wristpins, etc., and the water condensed in the crankcase contained no free acid, but did contain some $FeSO_4$. When using a gasoline of 0.151 per cent sulphur the corrosion was very appreciable and the water in the crankcase contained free sulphuric acid in small quantities, and when using a gasoline of 0.458 per cent sulphur the corrosion was very serious and the crankcase water quite acid. No doubt the same or similar results may be expected from large amounts of sulphur in fuel oil used in Diesel engines.

At the Recent Fall Meeting of the American Welding Society in Detroit, G. R. Borphy and S. W Miller agreed that the impurities in ordinary tank steel tended to contaminate and weaken the weld even where the filler rod itself is of high-grade material. For this reason they urged that only "firebox" steel be used for welded pressure vessels where great strength is important.

A 1,250 Horsepower Compound Uniflow Marine Engine*

By Prof. J. Stumpf

IN VIEW of the success of the uniflow engine in stationary practice it is remarkable that its application to ship propulsion has not made greater strides. This, however, has been due to the limitations possessed by a single-cylinder design.

To overcome the objection of incomplete expansion of high-pressure steam in a single cylinder, a 1,250-hp. compound marine engine has been built recently. This consists of two units each with a contraflow high-pressure cylinder *C* that exhausts into a low-pressure uniflow cylinder *D*, one unit of which is shown in Fig. 2. A standard piston valve *B* between each pair of high- and low-pressure cylinders controls the steam admission to both cylinders.

The superheated steam enters at the center of the valve casing. Part of its superheat is given up to the valve pistons and clearance surfaces, which relieves the high-pressure cylinders from excessive temperatures. A portion of this heat is recovered by the exhaust on its way to the low-pressure cylinder through the passage *F*.

A single balance piston at the top of the piston valve rod holds the valve in axial balance. The pressure in the lower clearance space is communicated to the top of the balance piston by the hollow valve spindle, which neutralizes the effect of a variable exhaust pressure and makes a second balance piston unnecessary.

*Abstract from *Werft Reederei Hafen.*

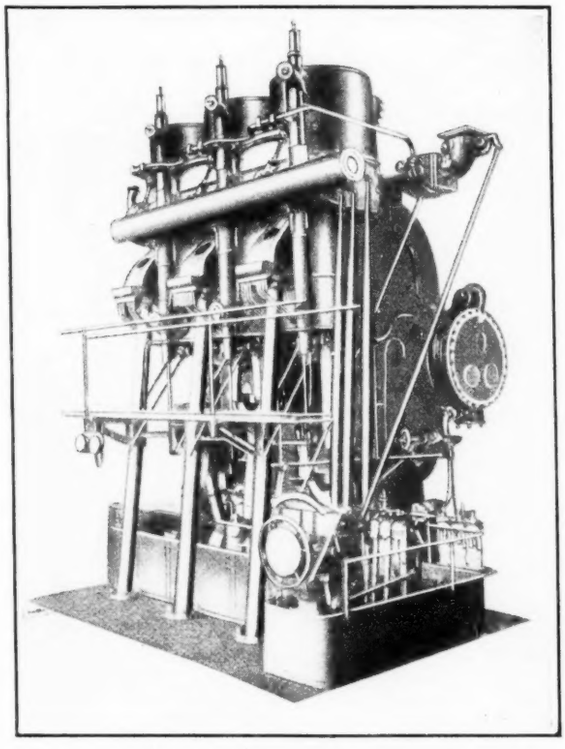


Fig. 1—Three-cylinder uniflow marine engine built in Denmark

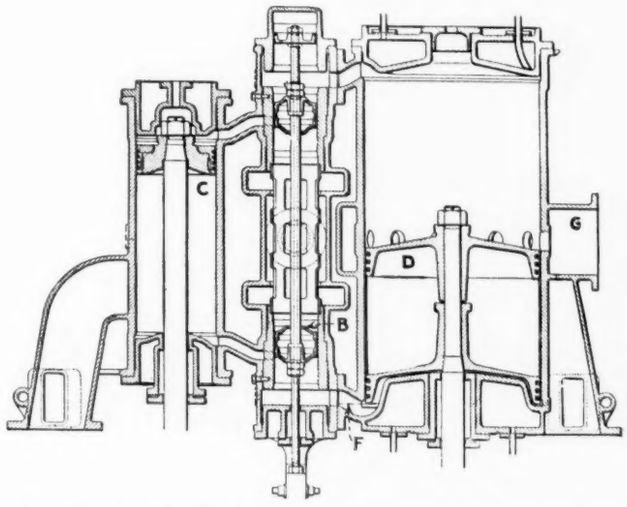


Fig. 2—One-half of a twin compound uniflow engine

The high-pressure cylinder is cast integrally with the valve housing, which is bolted to the low-pressure cylinder. The low-pressure cylinders are bolted closely together, which results in a very compact construction. The over-all length for the assembled four cylinders is only 160 inches.

In this engine two standard piston valves replace twelve poppet valves. A simple Marshall valve gear replaces complicated cam mechanisms.

The shaft is a one-piece forging. The two high-pressure cranks are set 90 deg. apart, and each low-pressure crank is set 150 deg. behind its respective mate. This setting results in a favorable crank-effort diagram. The non-rhythmic character of the curve shows that a condition of resonance from torsional vibration is unlikely to occur.

A cylinder ratio of 1 to 5 is recommended for normal expansion, but if the expansion is to be continued down to an end pressure of 7.3 lb. absolute, the cylinder ratio should be 1 to 7.

With the piston valve the high-pressure cylinder clearance volume is only 8 per cent and that of the low-pressure cylinder is 6 per cent. This is in contrast to the

usual 20 per cent and 9 per cent respectively found in contraflow engines.

The 150-deg. crank angles afford other inherent advantages in steam admission. When the cranks are set 180 deg. apart, the opening of the low-pressure cylinder port must be simultaneous with the closing of the high-pressure cylinder port. Compression, therefore, takes place during a considerable part of the high-pressure piston stroke and large clearance losses become unavoidable. When the low-pressure cranks are only 150 deg. behind, compression in the high-pressure cylinder may be delayed up to 13 per cent of the stroke with a moderate lead of the low-pressure cylinder admission. At dead center exhausting loss of the steam passing into the low-pressure cylinder is experienced. Owing to the smaller low-pressure cylinder clearance there is less sudden pressure drop at the end of the high-pressure indicator diagram. Finally, the time during which the high-pressure cylinder exhaust is open and that for filling the low-pressure cylinder are materially increased. The expansion in the high-pressure cylinder is more complete and less trouble from distortion of connecting passages due to high superheat results.

Since the low-pressure cylinder can exhaust freely through the large cylinder slots into the condenser, there

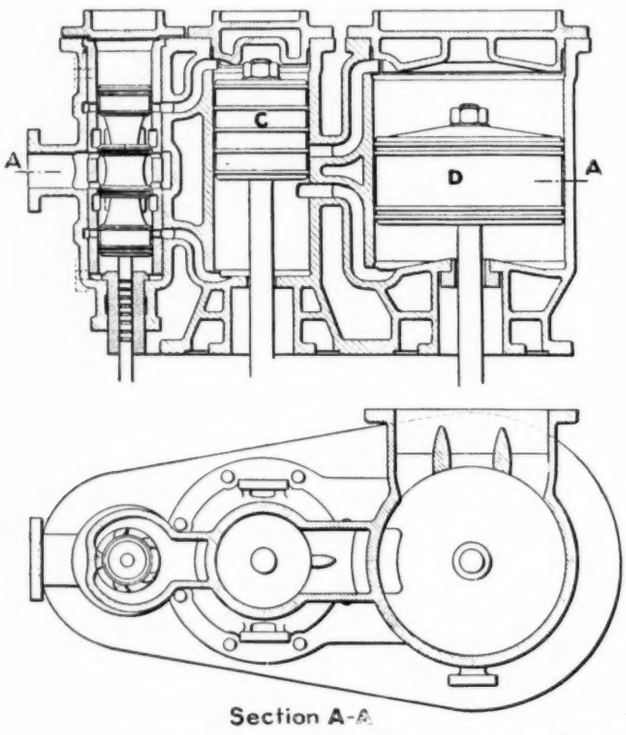


Fig. 3—Cross-section of a small compound uniflow

is not the loss by throttling at this point, as is the case with engines having exhaust valves. For this reason it is evident that a high vacuum can be efficiently utilized in a reciprocating engine of the uniflow type. A vacuum up to 96 per cent is permissible, in contrast to the maximum of 85 per cent vacuum with contraflow engines.

The slightly lower condensate temperature that results, is easily regained by utilizing the exhaust from steam air ejectors or from other auxiliaries. The steam consumption is less than that of triple-expansion engines with low-pressure turbines, this latter combination having a water rate of from 8.7 to 8.9 lb. per indicated horsepower.

A smaller compound engine in which both the high- and the low-pressure cylinders are uniflow is shown by Fig. 3. The cranks are set 120 deg. apart, and a single piston valve admits steam to the high-pressure cylinder *C*. The high-pressure piston controls the steam admission into the low-pressure cylinder *D*. Due to the crank setting the engine can run in one direction only.

What Do You Know?

The answers are on page 517

THERE are about 2,500,000 horsepower of oil engines in the power plants of this country. Engineers do or should know all about them. Below are ten questions on the subject, and all engineers of a steam plant should have enough general information on oil engines to answer at least six.

Ques. 1—What is the outstanding difference between a gasoline engine and a Diesel engine?

Ques. 2—How high a compression pressure is it necessary to carry in a solid-injection four-stroke-cycle Diesel to insure steady operation?

Ques. 3—Discuss two ways by which cooling water is introduced into the piston head of a piston-cooled Diesel.

Ques. 4—In an air-injection Diesel to what pressure is the injection air carried?

Ques. 5—Why not compress the injection air in a single stage?

Ques. 6—How much power does the air compressor of a Diesel require?

Ques. 7—If the fuel injection is early in a Diesel, what evidence is given of the fact?

Ques. 8—How would you proceed to scrape a crank-pin bearing?

Ques. 9—What is the igniting temperature of fuel oil in degrees F.?

Ques. 10—What does "degree Baumé" mean?

Supersaturation *and the* Flow of Wet Steam

PART II—THE FLOW OF WET STEAM

By G. A. GOODENOUGH

Professor of Mechanical Engineering, University of Illinois

IN THIS second article, Professor Goodenough concludes his masterly discussion of a subject important to those who are concerned with the theory of the steam turbine. The first article appeared last week.

AS HAS been shown in the first article, published last week, the water formed by condensation after undercooling is a mist of fine particles. It is not likely that the water persists in this form throughout the flow through the turbine. Probably the particles coalesce into a film on the walls of the passages, and the jet of steam flowing through the passage tears away relatively large drops from the film and carries them along. It is assumed, therefore, that the water in the flowing steam is for the most part in the form of large drops, that is, drops having a diameter of the order 10^{-3} to 10^{-5} ft. (0.0001 to 0.01 in.).

The maximum size of drop that can be carried by the steam depends on the density and speed of the steam.

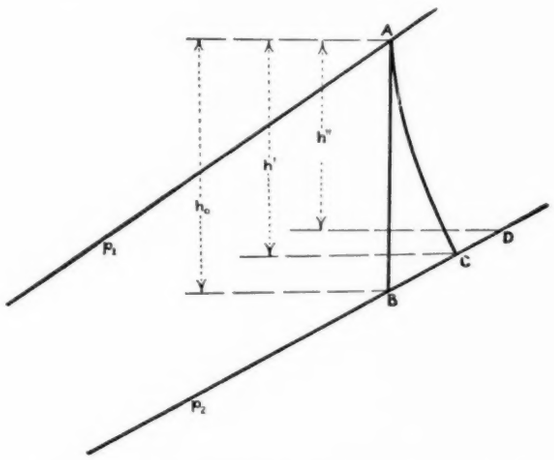


Fig. 1—Mollier diagram (total heat—entropy) showing expansion of wet steam

For an admirable discussion of this topic the reader is referred to an article by Prof. G. B. Upton; "Rain Drops in Engineering," Sibley Journal of Engineering, January, 1923. Following Professor Upton's development the maximum diameter of the drop is given by the formula

$$d = 233 \frac{\sigma}{(w-u)^2} \qquad (1)$$

in which

σ = surface tension of water
v = specific volume of steam
w = velocity of steam
u = velocity of water drop

A mean value of σ is 4.15×10^{-3}, and with this value the formula becomes

$$d = 0.97 \frac{v}{(w-u)^2} \qquad (1a)$$

From the usual laws of motion, the expression for the acceleration of a drop is found to be

$$\frac{du}{dx} = 0.00527 \frac{(w-u)^2}{u\,v\,d} \qquad (2)$$

By means of these equations it is possible by a step-by-step process to get a rough idea of the velocity u of a water particle. The following results were obtained in a concrete case:

The initial pressure p_1 was taken as 31.88 lb. per sq.in., corresponding to an experiment in the General Electric laboratory. It was assumed that the steam approached the nozzle with a velocity somewhat greater than 100 ft. per sec., so that the initial difference $w-u$ might be taken as 100. With this assumption the maximum diameter d was found to be 0.00125 ft., and equation (2) for the acceleration became

$$\frac{du}{dx} = 4.22 \frac{(w-u)^2}{u\,v}$$

The nozzle was divided into ten sections; and by the usual equations of flow were determined the steam velocity w and the specific volume v at each section. The step-by-step integration then gave the following results:

Section	1	2	3	4	5	6	7	8	9	10
w	340	400	470	540	630	728	842	970	1100	1225
u	40	48	56	65	76	88	101	116	133	150

In this particular case it appears that the ratio u/w is nearly constant through the nozzle and has a value of about 0.12. That is, on the average the speed of the water drops is about $\frac{1}{8}$ the speed of the steam.

It is to be understood that this result merely expresses the order of magnitude of the ratio u/w. By a change in the assumption of the initial value of the difference $w-u$, the ratio might be raised to 0.15 or decreased to 0.10. All that can be said with assurance is that under the given conditions the value of the ratio is likely to lie between the limits 0.08 and 0.20.

The value of the ratio u/w must depend on the initial pressure, for with higher pressure the specific volume v is smaller, hence from (1a) d is smaller and from (2) the acceleration $\frac{du}{dx}$ is larger. With an initial pressure of 60 or 80 lb. the ratio may perhaps fall as low as 0.05.

The fact that the speed of the water drops is only

a small fraction of the speed of the steam has a decided effect on the discharge of wet steam. This effect will be shown by a consideration of the usual equations of flow.

In Fig. 1 let A represent on the Mollier chart the initial state of wet steam at pressure p_1; then the point B will represent the state after frictionless adiabatic expansion to the pressure p_2. The segment h_0 ($= AB$) represents the decrease in total heat during the expansion. When friction is taken into account the point C represents the state at the end of expansion, and the segment h' the decrease in total heat. If it is assumed that the initial velocity is negligible, as in flow from a boiler, the exit velocity is obtained from the equation

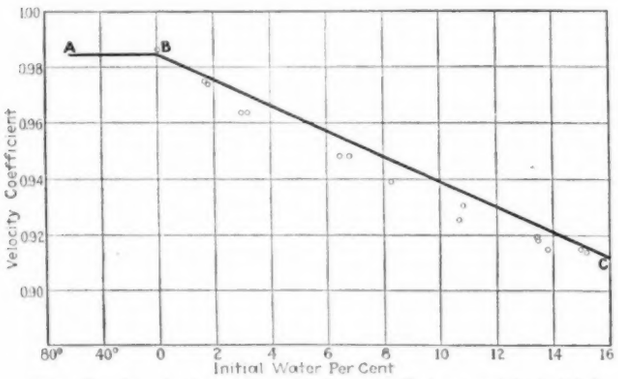


Fig. 2—Variation of velocity coefficient with initial moisture content of steam

$$A\frac{w_0^2}{2g} = h_0 \text{ without friction} \qquad (3)$$

$$A\frac{w'^2}{2g} = h' \text{ with friction} \qquad (4)$$

$$A = \frac{1}{778}$$

In the deduction of these equations it is assumed that all particles in a given cross-section, whether steam or water, have the same velocity and the gain of kinetic energy by the fluid is placed equal to the loss of total heat.

Now let account be taken of the slower speed of the water particles.

Take x = quality of mixture

$y = 1 - x$, weight of water in 1 lb. of mixture

f = ratio u/w

Taking the initial velocity as zero, the increment of kinetic energy of the steam is $x\frac{w^2}{2g}$ that of the water is $y\frac{u^2}{2g} = y\frac{(fw)^2}{2g}$. The sum of these is

$$\frac{w^2}{2g}(x + f^2y)$$

and, as before, this increase of energy of the fluid is equal to the decrease of total heat. However, the interaction between steam and water particles, as in all cases of impact, causes a certain additional loss of energy which is reflected in an increase of the total heat at the lower pressure p_2. So that the final state is represented by some point as D, Fig. 1, and the decrease of total heat is h''. Denoting by w'' the velocity of the steam for this third case, the equation of flow becomes

$$A\frac{w''^2}{2g}(x + f^2y) = h'' \qquad (5)$$

Let

$$h' = k_1^2 h_0$$

$$h'' = k_2^2 h' = k_1^2 k_2^2 h_0$$

Then a comparison of equations (3), (4) and (5) gives the following relations

$$\frac{w'}{w_0} = k_1 \qquad (6)$$

$$\frac{w''\sqrt{x + f^2y}}{w'} = k_2 \qquad (7)$$

The coefficient k_1 is merely the velocity coefficient as usually defined. It accounts for the fluid friction between steam and nozzle walls and may be considered as a constant. The coefficient k_2 arises from the interaction between steam and water drops, and it should vary with the amount of water present. The following expression for k_2 based on the law of inelastic impact was deduced by J. H. Keenan of the General Electric Company and verified by the writer.

$$k_2^2 = \frac{x + f^2y}{x + fy} \qquad (8)$$

The insertion of this expression in Eq. (7) gives

$$\frac{w''}{w'} = \frac{1}{\sqrt{x + fy}} \qquad (9)$$

It appears, therefore, that the steam velocity w'' is greater than the hypothetical velocity w' calculated on the usual basis. The excess of w'' over w' is larger the greater the amount of water in the steam.

Since the discharge is practically proportional to the steam velocity, the ratio of the discharge calculated correctly with the ratio f taken into account, to the discharge calculated by the usual formula (with $f = 1$) is likewise $\frac{1}{\sqrt{x + fy}}$. The following figures show this ratio for $f = 0.15$.

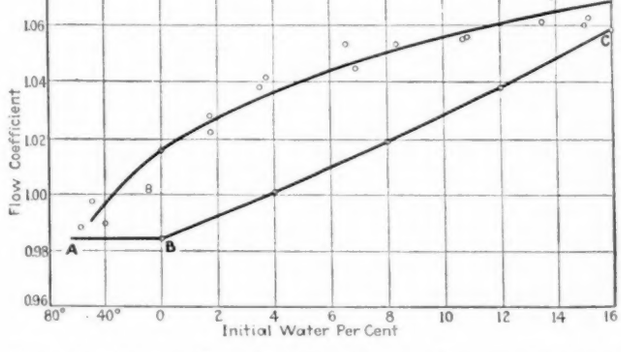


Fig. 3—The coefficient of discharge of a steam nozzle as influenced by supersaturation and by moisture in the steam

y =	0	0.04	0.08	0.12	0.16
x =	1.00	0.96	0.92	0.88	0.84
$\frac{1}{\sqrt{x + fy}}$ =	1.00	1.017	1.036	1.055	1.076

Thus with 12 per cent water in the initial mixture, the

discharge correctly calculated is 5.5 per cent greater than the discharge calculated on the assumption of equal speed of steam and water. To put the matter in another way: When the steam is initially wet the discharge coefficient is likely to be greater than 1 merely because the system of calculation gives too small a value for the theoretical discharge. Hence a discharge coefficient greater than 1 does not necessarily imply supersaturation.

The effect of the slower speed of the water drops is well shown in the variation of the so-called velocity coefficient with initial water in the steam. In a set of

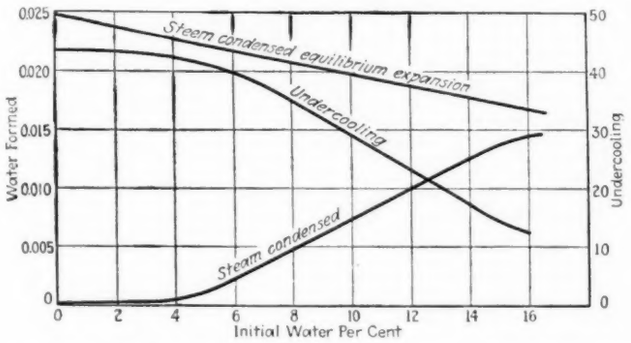


Fig. 4—Fresh condensation and undercooling for the expansion of initially wet steam

experiments conducted by the General Electrical Company the initial pressure was 31.88 lb. per sq.in., the pressure ratio $\frac{p_2}{p_1}$ was 0.65 and the initial conditions were varied from 200 deg. superheat to 15 per cent water in the steam. The measured reaction R and the measured weight flowing per second when introduced into the usual reaction equation

$$R = \frac{M w}{g} \qquad (10)$$

gave values of the supposed velocity w; then a comparison of the value of w so obtained with the theoretical w_o of frictionless adiabatic flow gave values of the velocity coefficient C_w. The points in Fig. 2 represent the values of C_w thus found. It will be observed that C_w decreases as the amount of water in the steam increases.

An expression for C_w, taking account of the slower speed of the water particles is obtained as follows: The weight of steam flowing per second is xM and the velocity is w'', the weight of water is yM and the velocity is fw''. Hence the proper reaction equation is

$$R = \frac{xM}{g} w'' + \frac{yM}{g} f w'' = \frac{M}{g} w'' (x + fy) \qquad (11)$$

By definition

$$C_w = \frac{w}{w_o} \qquad (12)$$

where w is obtained from Eq. (10). Therefore eliminating w

$$C_w = \frac{Rg}{Mw_o}$$

From Eq. (11)

$$\frac{Rg}{M} = w'' (x + fy)$$

hence

$$C_w = \frac{w''}{w_o} (x + fy)$$

Now from equations (6) and (9)

$$\frac{w''}{w_o} = \frac{k_1}{\sqrt{x + fy}}$$

Therefore, finally

$$C_w = k_1 \sqrt{x + fy} \qquad (14)$$

This equation shows that the coefficient C_w steadily decreases as the initial water in the steam is increased. With $k_1 = 0.984$, which was indicated by the experiments quoted, and with $f = 0.15$, the values given by Eq. (14) are represented by the line ABC Fig. 2.

While supersaturation may influence somewhat the course of the C_w curve, there is nothing in the theory of supersaturation to account for the progressive decrease of C_w with increasing values of y. This phenomenon is accounted for solely by the difference in speed of the steam and the water drops; and the agreement of the experimental points and the theoretical curve BC, Fig. 2, shows that the value 0.15 for the ratio f is a good choice.

In Fig. 3 the points show the values of C_g, coefficients of discharge, for the same set of experiments. It will be noted that these values rise above 1 even while the steam is initially somewhat superheated. It has been customary to ascribe the excess of C_g to supersaturation alone, but such an assumption is quite incorrect. Taking no account of supersaturation, the theoretical values of C_g are given by the equation

$$C_g = \frac{k}{\sqrt{x + fy}} \qquad (15)$$

in which k denotes the constant value of C_g that applies in the region of superheat. Taking $k = 0.984$, the line ABC, Fig. 3, represents the values of C_g obtained from Eq. (15).

For $y = 0$, the experimental value of C_g is about 1.015. The excess of this value over the value in the

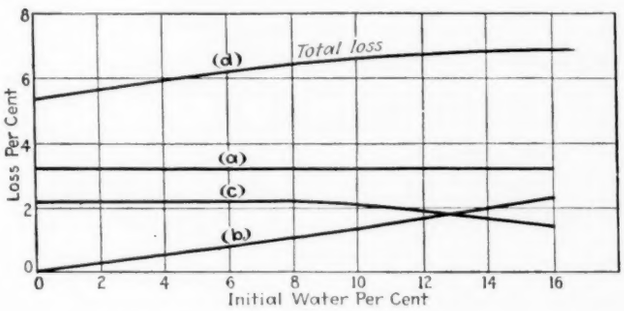


Fig. 5—Variation in losses in steam expansion with initial moisture content

superheat region is due solely to supersaturation. For $y = 0.08$, C_g is 1.05. Without supersaturation C_g would be 1.02; hence about one-half of the excess of C_g may be due to supersaturation, and about one-half to the slow speed of the water particles. For $y = 0.15$, nearly all the increment of C_g may be ascribed to the slow speed of the water, and supersaturation has little effect.

It is now apparent how the two phenomena, supersaturation and the lagging of the water drops, are interlocked. Neither phenomenon alone will account for all the experimental facts. When the steam is initially dry

or superheated only supersaturation need be considered; when the steam carries a large amount of water, say 20 per cent, supersaturation is practically negligible and only the slow speed of the water need be taken into account. Within these limits *both* phenomena require attention.

In Fig. 4 are shown the results of an estimate of the conditions of the steam at the exit from the nozzle. The data for the calculation were furnished by the experiments of the General Electric Company, quoted in connection with Figs. 2 and 3. Space need not be taken for a complete statement of the system of computation. The following is an outline. There are two unknowns, the temperature t_2 at the end of expansion, and the fresh condensation y; hence two equations of condition are required. One equation is obtained by equating two expressions for the final total heat i_2, the other from equating two values of the final volume v_2. One expression for i_2 is formed from the equation of flow, the other from the properties of undercooled wet steam at the pressure p_2. The same statement applies to the volumes.

The lower curve of Fig. 4 shows the amount of fresh condensation for different values of the initial water y. From $y = 0$ to $y = 0.04$ the amount of condensatoin is negligible; and the undercooling, as shown by the middle curve, is practically constant at about 43 deg. From $y = 0.06$ to 0.14 the condensation y increases almost uniformly, and the undercooling decreases uniformly. The upper curve shows the amount of condensation on the basis of equilibrium expansion. It is seen that for $y = 0.14$ to 0.16, the actual condensation is rapidly approaching the condensation under equilibrium conditions, and at the same time the undercooling is approaching zero. This means that with very wet steam supersaturation is to a large extent eliminated.

Energy Losses in the Nozzle

From the various relations that have been given it is possible to estimate for any value of the initial quality of the steam various energy losses involved in the expansion through the nozzle.

Referring to Fig. 1, h_o was taken as the decrease of total heat for frictionless adiabatic expansion. Friction between fluid and walls reduced h_o to $h' = k_1^2 h_o$; the internal interaction between steam and water drops gave a further reduction to $h'' = k_1^2 k_2^2 h_o$; and finally there may be a still further reduction due to supersaturation.

The symbol w'' was used in the preceding discussion to denote the actual velocity of the steam on the assumption of no supersaturation; let w_s'' denote the actual velocity when supersaturation exists. Equations (11) and (13) are equally valid with supersaturation, and (13) may be written

$$w_s'' = \frac{C_w w_o}{x + fy} \qquad (16)$$

The energy of 1 lb. of fluid at exit (x lb. with a velocity w_s'' and y lb. with a velocity $f w_s''$) is

$$\frac{w_s''^2}{2g}(x + f^2 y)$$

and substituting the expression for w_s'' given by (16), the energy per pound is

$$C_w^2 \frac{w_o^2}{2g} \frac{x + f^2 y}{(x + fy)^2}$$

Since $A \frac{w_o^2}{2g} = h_o$, the energy of 1 lb. of the flowing fluid corresponds to an effective decrease to total heat h_s given by

$$h_s = h_o C_w^2 \frac{x + f^2 y}{(x + fy)^2}$$

With h_o, h', h'', and h_s determined, the total loss may be distributed between the various effects.

The following calculation is made for $y = 0.08$.

$p_1 = 31.88$ lb. $p_2 = 20.72$ lb. $x_1 = 0.92$ $y_1 = 0.08$

$f = 0.15$ (assumed)

$k_1 = 0.984$ (from experiment)

$C_w = 0.939$ (from experiment)

$$k_2^2 = \frac{x + f^2 y}{x + fy} = \frac{0.92 + 0.15^2 \cdot 0.08}{0.92 + 0.15 \cdot 0.08} = \frac{0.9218}{0.932}$$

$$h' = (0.984)^2 h_o = 0.9683\, h_o$$

$$h'' = (0.984)^2 \frac{0.9218}{(0.932)^2} h_o = 0.9577\, h_o$$

$$h_s = (0.939)^2 \frac{0.9218}{(0.932)^2} h_o = 0.9357\, h_o$$

The losses are distributed as follows:

Friction in nozzle	$h_o - h' = 0.0317\, h_o$
Impact of steam and water drops	$h' - h'' = 0.0106\, h_o$
Supersaturation	$h'' - h_s = 0.022\, h_o$
Total loss	$h_o - h_s = 0.0643\, h_o$

The table gives the losses thus computed for various values of y, the initial water; and in Fig. 5 the results are shown graphically by the curves. The nozzle losses are expressed as a per cent of h_o the available energy in the steam.

In the superheat region the constant value 0.984 for C_w gives 3.17 per cent loss of energy due to skin friction. It is assumed that this loss is practically the same in the wet region. As soon as water appears in the steam the impact between steam and water drops gives rise to the loss designated as internal friction. This loss is nearly proportional to the amount of water present. The loss due to supersaturation remains nearly constant at 2.2 per cent until y reaches 10 per cent; then due to the decrease of undercooling as y increases, this loss begins to decrease. The total loss increases slowly and becomes nearly constant as the higher values of y are reached.

The table gives a fair picture of the losses in the nozzle. The numerical values depend, of course, on the assumed value of f. With $f = 0.20$ the values in the last three rows will be somewhat larger, with $f = 0.10$ they will be smaller.

LOSSES IN STEAM EXPANSION WITH VARIOUS VALUES OF INITIAL MOISTURE CONTENT, IN PER CENT OF AVAILABLE ENERGY

Initial moisture content	0	0.04	0.08	0.12	0.16
Friction in nozzle curve (*a*)	3.17	3.17	3.17	3.17	3.17
Internal friction curve (*b*)	0	0.51	1.06	1.65	2.29
Supersaturation curve (*c*)	2.16	2.21	2.20	1.93	1.37
Total loss curve (*d*)	5.33	5.89	6.43	6.75	6.83

The losses in the turbine bucket present an entirely different picture. It is quite evident, that the serious loss due to water in the steam (excluding supersaturation) is in the bucket rather than in the nozzle, and that it is due almost entirely to the velocity of the water drops being less than the velocity of the steam as they enter the bucket.

Some Notes on Steam Turbine Development

VI. Contemporary Developments

By W. J. A. LONDON

IN STUDYING the wonderful developments made in the design of the steam turbine itself, and confining our thoughts along these lines only, we overlook the important part played in these developments by practically every other branch of engineering.

However perfect the design of the turbine might be, it would be of little practical utility without the contemporary developments of the metallurgical, the electrical and the condenser engineer. While it is fair to state that the highly efficient turbine of today owes its success to the perfecting of other apparatus, it is also in order to state that, had it not been for the possible efficiencies obtainable by the turbine (it is only a turbine that can economically utilize extremely high vacua), there would not have been the same incentive to improve efficiencies along other lines.

IN THE last article of the series, the many developments in other lines of engineering and industrial activity, which had a distinct bearing on the progress of steam turbine design, are discussed by Mr. London.

The economic and commercial advantages obtained by increasing the speeds, and consequently the stresses were made possible by the commercial production of forgings having a yield point in excess of 100,000 lb. per sq.in. This has been made possible by the remarkable developments in the metallurgical field. Then we have had the extensive research to produce material that will satisfactorily resist erosion while retaining specified physical characteristics.

The progress made in the design of dynamo electric machinery has had, of necessity, to keep in step with that of the turbine itself. Any reference here is confined to the mechanical construction of turbine-generators, as questions of efficiency, regulation, etc., are ones of natural progress in the electrical field at large.

In the first turbine-generator (1884) Parsons was confronted with as hard a proposition in designing his generator, to run 18,000 r.p.m., as that of the turbine itself.

Until 1888 all generators built were of the direct-current types, and for many years after that the large majority of machines shipped had to be of this design to meet the demands of the market.

The history of the direct-current turbine generator, from the time of the metal brushes, which had to be adjusted by hand for each load, to the modern fixed carbon-brush construction, is a particularly interesting one to the designer. The compromises that had to be resorted to, for instance, in the dynamo itself, in order to provide adequate mechanical strength with minimum electrical losses, followed by the determination of the speed to give the best efficiency, would make an interesting story.

As machines grew larger and the mechanical limitations of the generator were exceeded with any reasonable turbine speed, two generators had to be resorted to in order to give acceptable over-all efficiency. This practice continued (practically always with a concession on the part of the turbine builder with regard to speed), until the universal adoption and acceptance by the customer of speed-reducing gears permitting the use of the most satisfactory speeds by both turbine and generator builders.

Another distinct branch of engineering materially affected by the development of the turbine is the machine-tool industry. For many years the high-speed double-helical reduction gear was really an integral part of the De Laval turbine and as such was, strangely enough, never considered as a commercial commodity elsewhere. In fact, all other turbine builders looked upon the gear as an invention of the evil one and to be avoided at all costs.

The advantage of the gear drive, however, gradually made itself manifest, opening up as it did all sorts of additional possibilities of turbine drive, and the old prejudices were forgotten. Mechanical limitations controlled the speed of such apparatus as direct-current generators, and fundamental principles limit the speed of low-lift pumps, low-pressure fans and screw propellers. The acceptance of this situation and the now universal adoption of the reduction gear have led to great developments in gear-cutting machinery by numerous makers.

Apart from the actual designing and cutting of a satisfactory tooth to run at a contact speed of 100 to 200 ft. per second, other interesting problems arose when gears of large capacity came to be seriously considered. Some of the problems anticipated and encountered are of particular interest.

The development of the large gear received its greatest impetus from the vast possibilities it presented in the marine field. The steam turbine had established itself as a practical and efficient marine engine for high-speed vessels; that is, in installations where the turbine could be directly connected to the propeller and run at a speed that would give acceptable economy. This class of vessel, however, constitutes but a small percentage of the world's

total tonnage, and all authorities agreed that if the turbine was ever to become a serious competitor of the reciprocating engine in tramps or freighters, something of a very radical nature had to be introduced.

In this connection James Denny, in his presidential address before the Institution of Marine Engineers in Great Britain, Oct. 5, 1908, said:

> It has frequently been suggested that if some inspired engineer would evolve a system of gearing that would be lasting and reliable, not too noisy and would not absorb in friction more than, say, 10 per cent of the power, turbine engines would be capable of application to any speed of vessel and to any size of propeller; you would then have a high-speed turbine and a low-speed propeller, which is the ideal condition for marine propulsion.

The late Rear Admiral George W. Melville and John H. Macalpine, acting in the capacity of consulting engineers for George Westinghouse, investigated the marine turbine situation and, having formed the same conclusion as the other authorities referred to, were bold enough to suggest the gear drive, but not without careful study and a thorough analysis of the problems involved.

The investigations made by Macalpine and the suggesting of the floating frame to overcome what appeared to be the major difficulty—namely, the equalizing of the tooth pressure across a wide face—are worthy of special mention, irrespective of whether authorities now agree as to the necessity or otherwise of this apparent complication. Nevertheless, it is safe to say that, with the state of the art of gear cutting at that time, it is questionable if the 6,000-hp. gear built and tested by Westinghouse in 1909 would have been so epoch-making as it was if it had not included this clever innovation.

The Alquist laminated gear, designed for the same purpose, is a device for getting the results obtained in the floating frame by flexibility in the gear itself.

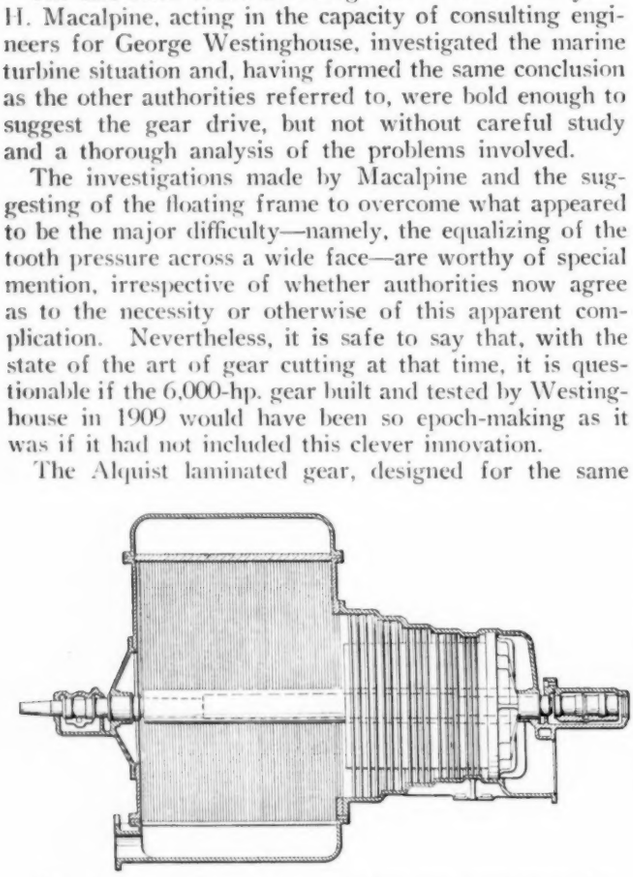


Fig. 1—Parsons combined turbine and condenser for which a patent was granted in 1899

As in turbine practice, the necessity for stability in the gear unit as a whole is important, irrespective of whether the gear is mounted solidly in the bearing or supported by elastic members. The housing itself, even in very small gears, must be rigidly constructed if quiet and smooth operation is to be expected. In the gear-cutting machine itself the question of rigidity is naturally one of most vital importance.

To sum up briefly the influence the development of the steam turbine has had in other spheres, it is not too broad a statement to say that, with the ability of the turbine to operate through ranges of temperature impracticable in other types of steam engines, the effect has been felt from the boilers back to the feed pump. Not only does this include running apparatus such as pumps, blowers, etc., but such diversified appurtenances as pipe joints, air washers, etc. The experience of the turbine engineer has been of immense value to the designers of pumps, blowers and other high-speed machines.

Modern Development Based on Old Principles

A retrospective review of the development of the steam turbine brings out one point of unusual interest; that is, how few of the modern innovations are really new and how many of them are merely the practical applications of suggestions made by the early pioneers. In many cases they are actually a resurrection of principles discarded twenty-five years ago as impracticable or valueless.

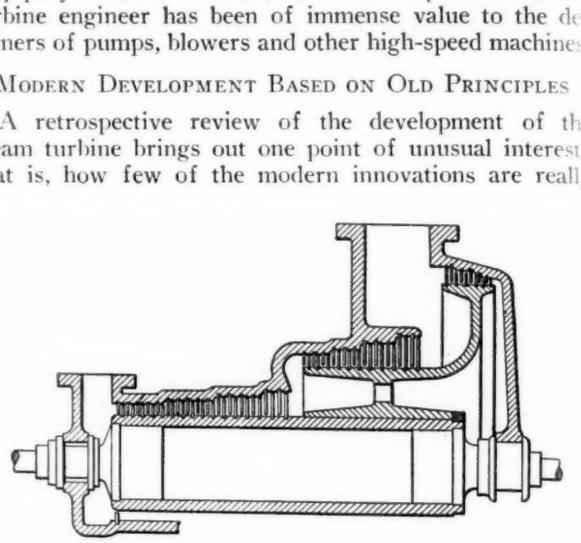


Fig. 2—Idea, for which a patent was granted in 1909, to superimpose blading barrels of reaction turbine, thus eliminating the dummies

While the double-flow machine today is in no way comparable with the first Parsons turbine (the introduction by the Westinghouse company of this principle being a development of distinct merit), it is, nevertheless, interesting in passing to note that the machine built in 1884 was of this type.

The multi-cylinder construction originated by Parsons in 1900 (for land work) having previously been applied to marine applications, lasted just a few years. It was re-introduced into this country in 1913 by the Parsons company in its 25,000-kw. machine at Fisk Street, and is again standard practice for all large units.

Reheating between cylinders was first tried out on the test floor of the Parsons plant in 1900, with the two-cylinder, 1,000-kw. turbine built for Elberfield. Experiments were also carried out by Westinghouse, which confirmed the conclusion of Parsons that, with the range of temperatures then employed, there was nothing in it. Again, the refinements resulting in efficient feed-water heating had not been developed.

The adoption of the vertical condenser, so popular in England twenty-five years ago, is also interesting. While the prevalence of dirty water in so many of the British stations made the vertical design the only logical one, it is worth while to note in passing that long before these were put in commercial operation with turbines, Parsons had taken out a patent (1889) for a combined turbine and condenser as shown in Fig. 1, which bears a marked resemblance to the actual 50,000-kw. installation at Crawford Avenue made by this company comparatively recently.

In impulse turbines the gradual elimination of the so-called Curtis element in favor of the single-row throughout, is but a return to Rateau's ideals as laid down in 1898. It should be mentioned here, however, that while some of Curtis's patents may have antedated those of Rateau, claiming a priority as far as the single-row construction is concerned, his (Curtis's) patent drawings do not show an appreciation of the number of stages necessary for the economical application of this principle, while Rateau's drawings clearly did.

Increasing the vacuum by means of steam-jet ejectors was first introduced about 1902 by Parsons in what he called his Vacuum Augmentor. A patent applied for in 1909 and shown in Fig. 2, was an early suggestion for superimposing the blading barrels of a reaction turbine for the entire elimination of dummies.

It must be gratifying to Sir Charles Parsons that he has lived to see what his achievement of 1884 has actually meant to the engineering world. Doctor De Laval fortunately lived long enough to see his reduction gear no longer scorned by the majority of turbine builders, but as an epoch-making device for the unlimited application of the steam turbine.

Care of Tools

THE PROPER care of tools in a station is as important as the care of the prime movers or the auxiliary apparatus. High-class maintenance work cannot be performed without good tools. Where they are of an inferior grade, or are taken care of in a haphazard manner, higher maintenance cost is bound to result. In the Marion plant of the Public Service Electric and Gas Co., of New Jersey, this fact is considered of prime importance. Tools are selected carefully for the work they are called upon to perform, and are inspected, repaired, and kept in first-class operating condition. Where tools are exposed to atmospheric conditions great care is exercised for their protection. Fig. 1 shows a one-ton chain hoist installed on a movable arm on the store room unloading platform. This is an outdoor installation, and is removed only for inspection or repair work. It is exposed to the elements, and a sheet-iron hood has been installed to prevent rain or snow from entering the mechanism. This hood is about 20 in. square, 12 in. high over all and is made of No. 16 galvanized iron. Designed with a slanting top to prevent the accumulation of moisture and installed to move with the hoist, it protects the mechanism from atmospheric conditions.

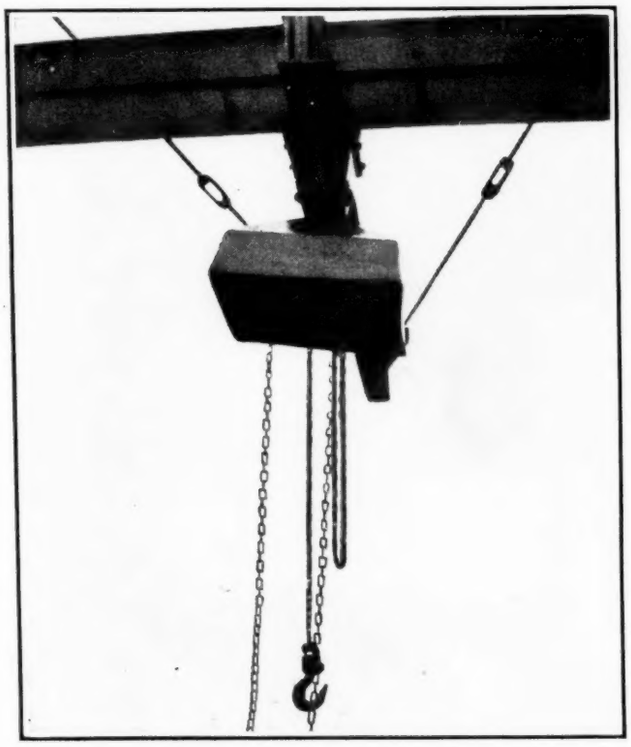


Fig. 1—Chain hoist hood to protect the mechanism from rain and snow

Answers to What Do You Know

The questions are on page 510

Ans. 1—In a gasoline engine the mixture is introduced before compression and is fired by an electric spark or other external means. In a Diesel only air is compressed, and this is raised to such a temperature that, when the oil is sprayed into this heated mass, ignition occurs without outside assistance.

Ans. 2—This depends upon the design of the combustion chamber. In all events the pressure must be at least 380 lb. per square inch.

Ans. 3—It may be introduced either by pipes having swinging joints or by a system of telescopic pipes.

Ans. 4—The injection pressure depends upon the type of fuel nozzle, a closed nozzle needing more than the open nozzle. For the former 900 to 1,050 lb. per sq.in. at full load is usual value, and for the latter 650 to 800 pounds.

Ans. 5—If air was compressed to 1,000 lb. in a single stage, the resulting temperature would be over 1,600 deg. F. By 3-stage compression the air can be recooled between the stages.

Ans. 6—About 8 per cent of the engine's full load output.

Ans. 7—Usually, there is a sharp metallic ring, similar to the sound in an automobile engine when going up a hill with early ignition.

Ans. 8—The journal or pin should be coated with lampblack or Prussian blue. The bearing half is then placed on the journal and given a rotating motion. Upon removal of the bearing, its high spots will be covered with the coating used. These spots are scraped, a little of the babbitt being removed. Upon again rotating the bearing on the pin, the number of spots showing blue are increased. These are scraped and the process continued until the entire babbitt surface is covered with the blue or the lampblack. This indicates that the bearing is in complete contact with the pin, and the job is finished.

Ans. 9—The igniting temperature is about 690 deg. F.

Ans. 10—The Baumé scale is an arbitrary standard used to measure the density of liquids instead of using the "specific gravity" hydrometer. The relation of a reading on Baumé hydrometer to that of a specific gravity hydrometer is expressed by the formula

$$Deg.\ Baumé = \frac{140}{s.p.g.\ reading} - 130.$$

For liquids heavier than water the constants 130 and 140 are replaced by 145.

ELECTRICAL *Operation and Maintenance*

Application and Operation of

Motor Controlled Valves

By K. M. WHITE

MOTOR-OPERATED valves have been in use for more than twenty-five years, but early installations consisted only of a motor, a train of gears and a reversing switch, without any of the control refinements found in modern valve-operating mechanisms. Valves in inaccessible places could be controlled in this way, however, and in case of a break in a high-pressure steam line the hazard to life and property was greatly decreased and interruptions to service reduced to a minimum. This last feature was of particular importance in central-station work and led to the installation of many motor-operated valves as an insurance measure.

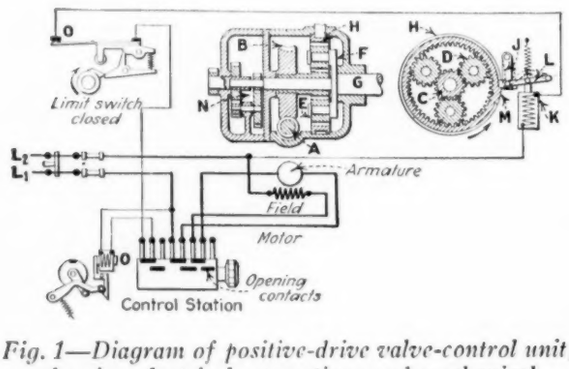


Fig. 1—Diagram of positive-drive valve-control unit, showing electrical connections and mechanical declutching device

Development has been rapid during the last five or six years, and motor operation has become practical for many types of valves. While the feature of quick and positive closure in emergencies increases in importance as control improves, motor operation has also justified itself from the viewpoint of convenience and economy. Control of all the important valves in a plant may be concentrated in a central control room and the valves may be located in inaccessible places if desired. Each valve may also be controlled from various points, and the closing circuit is sometimes given precedence to avoid interference from another station in an emergency. Valves are also often installed with automatic control by means of pressure switches, float switches and similar devices. Several unit-type operators (complete control units) which work with any valve are on the market, while some manufacturers build their operators into their valves.

An electric operator must close the valve positively and as quickly as possible, tightly seat it, and cut off the power at the right time. This requires properly designed motors and an accurate limit switch at the closing end. Lengthening of the valve stem due to expansion when hot makes it necessary that limit switches be set accordingly if adjusted when the valve is cold. Otherwise, power will be cut off too late and the stem sprung, unless provisions have been made in the operator for such emergency. Contraction of the ways of a gate valve in a steam line while cooling may cause the valve to freeze and most operators are provided with a lost-motion or

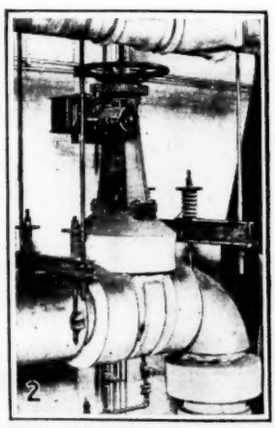
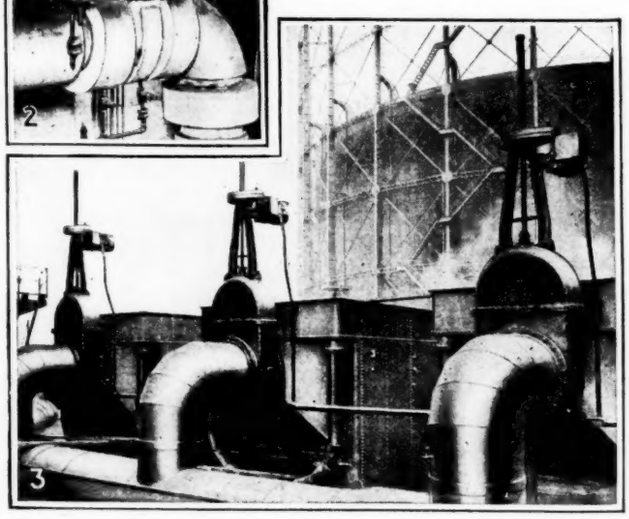


Fig. 2 — Motor-driven unit on a valve in a high-pressure steam line

Fig. 3 — Remote-controlled units on outdoor valves in gas lines



ELECTRICAL *Operation and Maintenance*

clutch device which allows the motor to gain speed before picking up the load. In addition, this method produces a hammer-blow effect, which unseats the valve.

These motors go through an operating cycle that requires high torque at one end with comparatively low torque and high speed desirable at the other. When a gate valve is near the open position, not much power is required, but as the seat is approached the line pressure builds up on one side of the valve and requires greater power. The available torque should be sufficient to close the valve in any emergency up to the limit of strength of the valve stem.

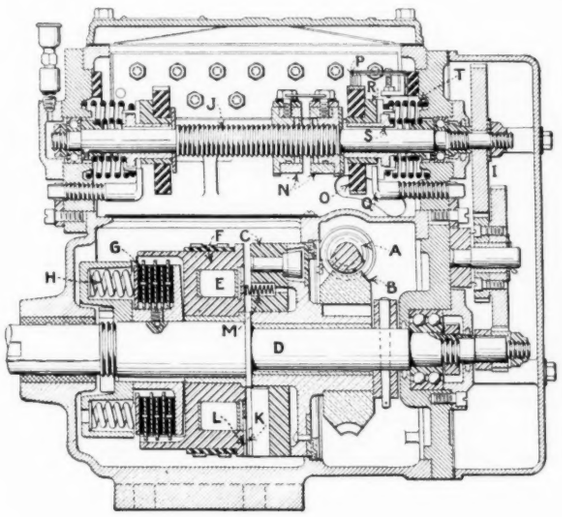
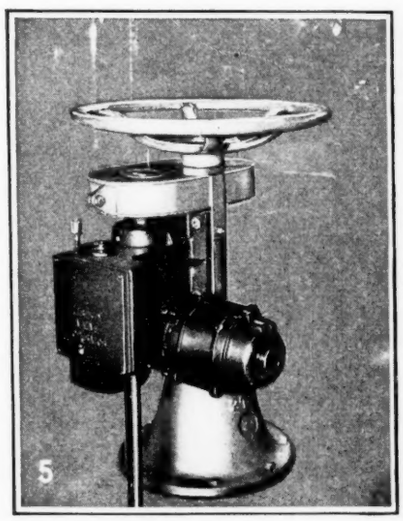
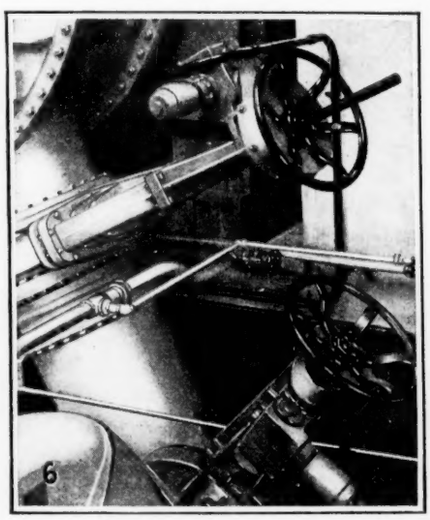


Fig. 4—(Above)—Section through valve operator employing magnetic driving clutch and a safety friction clutch, the latter to prevent subjecting the valve to excessive strains

Fig. 5—Unit mounted on a floor stand and controlling a 48-in. water valve

Fig. 6—Operators on two low-pressure valves in a condenser intake line





Operation is usually intermittent, so that heating need seldom be considered in motor design. A high-torque motor of essentially series characteristics satisfies the requirements and may be of relatively small size because of the intermittent load.

Closing speeds for valves in water lines are limited to about 12 to 18 in. per min. because of trouble from water hammer when higher speeds are used. On steam valves the speed may be about 18 to 24 in. per min. The size of the motor required for a given job is figured from the speed-torque curve of the motor. The normal maximum torque required to operate the valve under emergency conditions is obtained and a stem gear ratio decided upon. The desired closing or opening speed then fixes the motor speed, and the motor having that speed at the required torque is selected. A multiplying factor is used to allow for the increased rate of travel near the open position.

Operation of Dean Unit

Fig. 1 is a sectional view of the Dean unit, manufactured by the Cutler-Hammer Manufacturing Co., and includes a wiring diagram of the control system. The motor drives the valve through a worm gear and a planetary gear system. Motor shaft *A* drives a worm gear *B* which is keyed to a sleeve the other end of which forms the sun pinion C. The three planet gears *D* are mounted on a flange forming part of the slow-speed driving shaft *G*. The planet gears mesh into internal gear *H*, which revolves freely in a recess in the casing. When the motor is started, solenoid *K* is energized and straightens out toggle *L*, which moves pawl *J* to the position shown by the full line. By the time stop *M* has moved to the position shown, the motor has attained running speed, and a hammer-blow effect is transmitted to the drive shaft, unseating the valve. The motor is then directly connected by the gearing to the valve stem until the limit switch trips and causes solenoid *K* to release pawl *J*. The driving edge of this pawl is, however, tapered sufficiently to throw out against residual magnetism in the solenoid should the spring that releases the pawl be broken.

When the limit switch, operated from the driveshaft by a gear train *N*, is tripped, the drum switch at the control station is moved to neutral by solenoid *O* releasing its core; solenoid *K* releases pawl *J* at the same time,

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disengaging the motor from the drive shaft so that the drift of the motor's armature will not jam the valve onto its seat. Indicating lights on the control panel show the position of the valve. The valve may be operated by hand at all times that it is not being operated electrically, as the clutch is automatically disengaged. This equipment, therefore, does not require a means of manually declutching.

Fig. 2 shows this unit installed on a high-pressure steam-line valve. Three units operating valves in gas lines are shown in Fig. 3. Motors for operating gas valves must either be of the induction type to eliminate the explosion hazard due to commutator sparking, or inclosed in explosion-proof cases.

Valve Operator Has Safety Clutch

A magnetic driving clutch and a friction clutch of the multiple-disk type are features of the Liberty valve operator, made by the Liberty Electric Corporation. Since a liberal safety factor is always used in the valve-stem design, a friction safety clutch with a capacity of several times the normal closing torque is installed. This clutch is purely an emergency clutch and is not called on for duty except under abnormal conditions. It prevents undue strain being placed on the valve stem and parts in case any obstruction hinders the valve travel, irrespective of whether the valve is opening or closing, or further, in the event that the limit switch is set to trip too late or in case of failure of contactor or switch equipment.

Referring to Fig. 4, the motor drives gear B through worm A. The portion C of the magnetic clutch is attached to B and the whole is free to revolve about shaft D. Portion F of the magnetic clutch contains coils E and is connected to the driveshaft through the friction clutch G, a movement being allowed along the shaft with sufficient freedom to engage or disengage the magnetic clutch. The springs H are loaded to give the friction clutch its rated capacity as well as providing means of automatic take up in the event the clutch wears. Instantaneous disengagement at the end of the disk travel is due to the collapse of the field of the magnetic clutch and the separating action induced by the coil springs between the clutch and armature.

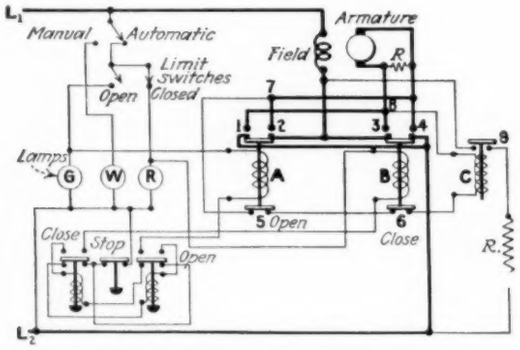

Fig. 7—Simplified wiring diagram of unit using dynamic braking on the motor at limits of travel

A hammer-blow effect for unseating the valves is obtained by means of the magnetic clutch. Release springs M tend to hold the clutch apart in the position shown. When the motor is started the clutch magnets are energized. The portion C rotates and F remains stationary until the driving keys K engage the slots L, at which time the motor has attained sufficient speed to unseat the valve as it picks up the load. The relatively high coefficient of static friction is used to enable the friction clutch to transmit this blow to the valve without slipping.

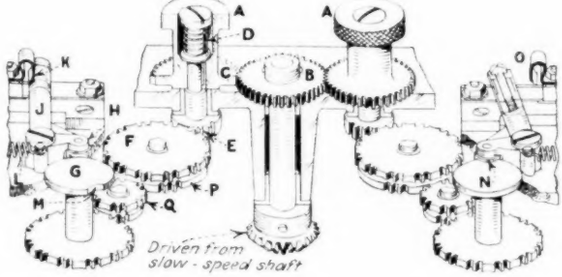

Fig. 8—Layout of unit-type limit-switch mechanism

Shaft J, driven by gear I, carries traveling nuts N which trip the limit switches. As N travels toward drum O, it forces sleeve S back. This sleeve carries cam R, the face of which is held against stop Q by tension in spring T. As the cam is forced back, the stop disengages from the face of the cam, releasing spring T, which rotates drum O and opens the motor and clutch circuit between contacts inserted in O and contact fingers P. The break is quick and the switch interrupts the magnetic-clutch circuit so that the valve will stop even though the motor may keep running owing to failure of contactor or control station. When the time shaft J reverses, the cam again engages Q and resets contact drum O at once, which gives power operation of the valve between narrow limits.

Two of these units operating low-pressure valves in a power plant are shown in Fig. 6, while Fig. 5 shows the unit mounted on a floor stand and operating a 48-in. water valve.

Type Using Dynamic Braking

Dynamic braking is used to stop the motor when power is cut off in the unit produced by Chas. Cory & Son, Inc. The drive consists of reduction gearing using spur gears, with a lost-motion collar which enables the motor to attain running speed before picking up its load. No mechanical clutch is disengaged except when working on the unit. The control and power circuits are shown in Fig. 7 with the power circuits in heavy lines. Assuming the valve is open, the closed-position limit switch is closed and the red lamp R is lighted. Pushing the close button completes a circuit from line L_1 through the manual-automatic switch (on the automatic side), the closed limit switch, contactor coil B, upper contacts of the close button, holding coil of the close button, lower contacts of the open button, the stop button and to L_2 line. The

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holding coil then holds the push button closed until the limit switch opens or the stop button is pushed. Contacts 3 and 4 (which are insulated from each other) close and start the motor. Its circuit is from L_1 through the series field, contacts 3, the armature, contacts 4 and to line L_2. The opening operation is started in the same way, but contactor A then closes and the current is in the reverse direction through the armature.

The motor now runs until the limit switch interrupts the control circuit, causing contactor B to open the motor circuit. When the contactor drops down, it completes the circuit which connects braking coil C across the armature. This circuit is from 8, at one side of the armature, through coil C, contacts 6 and 5 and to 7 at the other side of the armature. Coil C then closes contacts 9, which connect the field across the line through resistance R_1. Dynamic braking occurs, the motor acting as a generator quickly slows down and stops.

Since a shunt winding cannot be used with dynamic braking without complicating the control, resistance R is permanently connected across the armature, and connects the field across the line in series with it, whenever the motor is running. A definite minimum excitation is thus obtained at all times, preventing excessive speed at light loads.

A unit-type limit switch, Fig. 8, is used. One side is the closing and the other the opening limit. Knobs A may be pulled out against springs D and gear C turned the proper amount to set the limits. In operation, teeth E move gear F one set of notches at each revolution. Wheel P is fastened to F and moves Q in the same

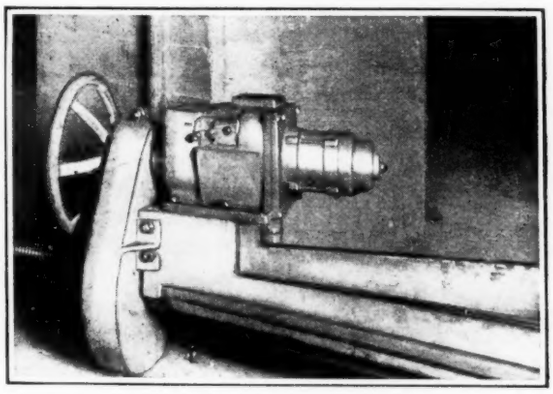


Fig. 9—Motor-operated 42-in. gate valve in a water line

manner, and so on to cam G. When notch M moves under roller H, the roller drops in and toggle J opens switch K, as shown at O. This operator is shown in Fig. 9 mounted on a large gate valve in a water line.

The motor is positively connected to the valve in the Chapman unit, made by the Chapman Valve Manufacturing Co. Hand declutching is employed when manual operation is desired or when working on the unit. The motors are low-speed, squirrel-cage for alternating-current circuits and compound-wound for direct current. They are inclosed and mounted on pads cast on a special yoke attached to the valve.

Geared limit switches with quick-break contacts are employed to make and break the control circuit. The motor circuit is handled by a magnetic contactor panel containing opening and closing contactors, mechanically interlocked to prevent the possibility of their both closing at once. Electrical interlocks hold the circuit closed

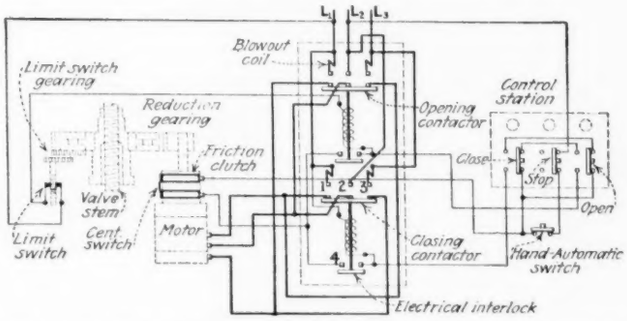


Fig. 10—Diagram of unit employing centrifugal switch on a friction clutch to cut off power when valve strikes seat

after the button has been released. An in-gear switch in the control circuits opens when a lever is thrown to the hand-operation position, thus preventing power being applied to the unit when it is being worked on or adjusted.

The motor shaft is directly connected to a pinion in the main casing. This pinion drives an intermediate gear and pinion, which in turn drives a large gear on the yoke nut. A pawl on this gear engages a pawl on the yoke nut or stem, depending on the type of valve, and opens or closes the valve, as the case may be. These pawls on both the large gear and the yoke nut occupy a small portion of the circle on which they are located, allowing the gear to make about three-quarters of a turn before the pawls engage. The motor is thus allowed to attain approximately normal speed before picking up its load, which it then does suddenly, the resulting blow unseating the valve.

Push-button stations have open, stop and close buttons, and start the corresponding operation when momentarily pressed. Indicating lamps show the position of the valve at all times.

Valve Seats at Reduced Speed

Seating the valve under reduced speed of the motor is accomplished in the unit manufactured by the Crane Co. No declutching device or instantaneous disengagement of the motor is included. This method allows the seating procedure to be governed by the temperature condition at the time of the operation. As in several other units described, a lost-motion mechanism causes a blow to be transmitted to the valve stem to unseat the valve after the motor has come up to a good speed.

A novel method of seating a valve is employed in the Kelty unit, manufactured by the Coffin Valve Co. The valve side of a multiple-disk friction clutch carries a centrifugal switch which is held closed by a weight

ELECTRICAL *Operation and Maintenance*

mounted on the switch arm, when the valve stem is revolving. When the torque increases as the valve strikes its seat, the clutch slips and the centrifugal switch opens the motor circuit. The valve is thus seated before the power is cut off, and the adjustment of the clutch determines the firmness of seating. The clutch slips in only one direction, allowing full torque to be applied for unseating the valve. A limit switch is used at the open end.

Fig. 10 is a diagram of the power and control circuits of a unit using three-phase induction-motor drive with remote control. Assuming the valve open, the closing operation is started by pushing the close button, which completes a circuit from line L_2 through the stop button, hand-automatic switch, the open and close buttons, the closing contactor coil, and to line L_1. Contacts 1, 2 and 3 are closed and connect the motor directly to the line. Interlock contacts 4 are closed at the same time,

DATA ON ELECTRIC VALVE OPERATORS

Manufacturer*	A	B	C	D	E	F
General:						
Can be used on any make valve	yes	yes	yes	no	yes	yes
(a) Require changes in valve	no	no	yes	yes	no	yes
Automatic or hand declutching	auto.	auto.	hand	hand	hand	hand
Friction clutch (Multiple disc.)	yes	no	no	no	no	yes
Lost motion device to allow motor to attain speed before taking on load of unseating valve and to produce hammer-blow effect	yes	yes	yes	yes	yes	no
Motors separate and attached to valve arch	no	no	yes	no	no	no
Recommended closing speeds for gate valves, in. per min.						
(a) water	12	4–12	18	12–15	12	12
(b) steam	24	20	18	18–24	18	18
Method of seating the valve:						
Instantaneous disengagement of motor and drive at extremes of travel	yes	yes	yes	no	no	no
Valve disk seated at reduced speed and torque of motor	no	no	no	yes	no	no
Valve disk seated to slipping torque of friction clutch	no	no	no	no	no	yes
Electric braking	no	no	no	no	yes	no
Motor:						
Characteristic type	series	series	compound	compound	series	compound
Maximum r.p.m.	4,600	4,000	900	900	4,000	900
Type of bearings	Ball	Ball	Ball	Ball	Ball	Ball
Control:						
Manual or push button operating switches, wall mounting	M&PB	M	PB	PB	PB	PB
Relay panel required						
(a) For all operation	no	no	yes	yes	yes	yes
(b) For multipoint operation	yes	yes	yes	yes	yes	yes
Quick-break limit switch	yes	yes	yes	yes	yes	yes

*References: A—Liberty. B—Dean. C—Chapman. D—Crane. E—Corey F—Kelty.

and when the motor starts the centrifugal switch closes. The push button may now be released and the holding circuit is through the hand-automatic switch, centrifugal switch, electrical interlock and the contactor coil to line L_1. The centrifugal switch will open and disconnect the motor when the valve strikes its seat or when the load exceeds the normal seating torque at which the friction clutch has been adjusted to slip.

The opening circuits are made in the same way, except that the holding circuit is through the stop switch instead of the centrifugal switch. The hand-automatic switch is opened in conjunction with a mechanical clutch when hand operation is desired.

Considerable variety is apparent in the various manufacturers' solutions of several of the special problems to be met in building valve operators. The significant features of each of the units have been collected and compared in the accompanying table. There are many special applications, such as automatically controlled pressure-reducing valves, float-controlled valves and others which offer individual problems.

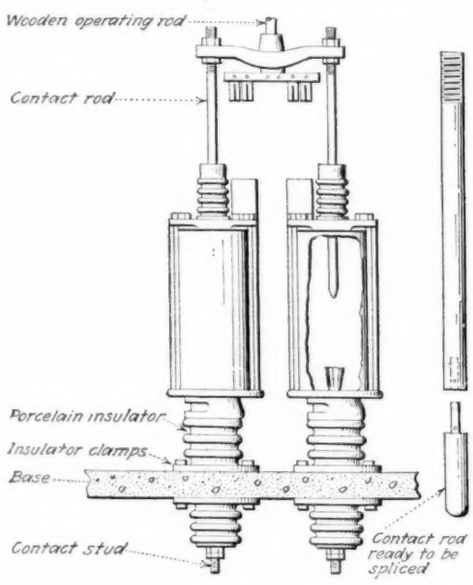
Motors always turning in the same direction are sometimes used when reversed rotation is not necessary in special cases. Solenoids have also been used, particularly on smaller apparatus.

Repairing Contact Rods on Oil Circuit Breakers

By Allen L. Donovan

REPAIRS to contact rods on oil circuit breakers are sometimes necessary when new rods are not on hand for replacements. This can be accomplished by splicing in a piece of 1-in. brass rod or a piece of an old contact rod to the one needing to be replaced.

Cut the old one eight or ten inches above the burned



New end spliced on oil-switch contact rod

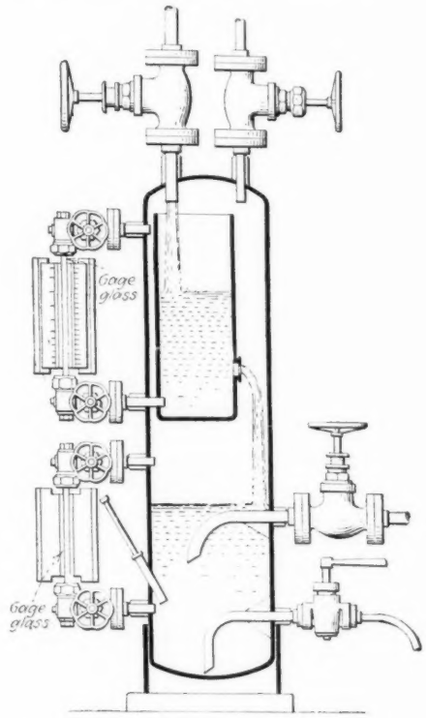
end, square in a lathe and drill a $\frac{1}{2}$-in. hole in the center of the rod about six inches deep. Then turn down the piece to be spliced in on one end for about six inches to a tight fit in the center hold of the contact rod. When the splice is made tight to the shoulder, drill and pin the joint in two places with $\frac{3}{16}$-in. pins, at right angles to each other. To complete the job, cut off and point the spliced end, leaving the rod long enough for some future length adjustment. Rods repaired in this manner have given satisfactory results for a long time.

Metering Refrigerating Liquids

IN AN article by R. Stuckle appearing in *Kalte*, Dec. 31, 1926, and reprinted in *Refrigerating Engineering*, a new method of measuring the refrigerating output of a plant is described.

The author explains that in refrigerating plants operating with dry compression it is an easy matter to determine roughly the refrigerating capacity by simply reading the temperature of the precooled ammonia before it enters the expansion valve, together with the pressure and temperature of the dry saturated or superheated ammonia vapor at the end of the evaporation. The total refrigerating capacity, however, requires exact measuring of the weight of the ammonia circulating.

The studies of Doerfel and the proposal of Plank led to the measurement of circulating ammonia by means of



Instrument to measure ammonia flow

the pressure difference existing in a sharp-edged orifice, transmitted to a spring gage. The measuring instrument is installed in the liquid line before the regulation valve. The defect of this apparatus is that its operation is dependable only when precooled or undercooled ammonia is used; otherwise too much gas develops in the apparatus, affecting its correctness.

An apparatus using this principle is built by the Gesellschaft fur Linde's Eismaschinen A.G. in Wiesbaden. The gages attached to the apparatus show on one scale the pressure difference of the refrigerant and on the second scale the refrigerating capacity. It is said that the apparatus shows not only the refrigerating capacity, but also derangements in the operation of the plant. If, for instance, a mixture of vapor and liquid or air and liquid, instead of precooled liquid, passes through the instrument, it is plainly shown so that the fault can be remedied.

The apparatus is also placed in the liquid line between the condenser and the valve. This instrument, however, uses the height of a liquid column in a vessel from which the liquid flows through a calibrated orifice. Glassel has introduced this instrument (shown in the illustration) into practical use. It consists of a cylindrical tank, in the upper part of which is placed a measuring vessel equipped with one or more calibrated orifices, which are adjustable in case one or more compressors are used.

The refrigerant coming from the condenser flows into the upper vessel and stabilizes itself at a certain height, determined by the amount coming from the condenser. The liquid flowing through the orifice collects in the lower part of the outside tank and from there flows through the expansion valve to the evaporator or expansion coils. By means of liquid gages, one on the measuring vessel and one on the lower part of the outside tank, the heights of the liquid in the measuring vessel and in the lower part can be read. The only requirement in order to avoid incorrect reading, is that the temperature of the liquid in the apparatus be lower than the corresponding temperature of the saturated pressure, so that evaporation and forming of gas bubbles are avoided. The Glassel apparatus shows not only the refrigerating capacity, but also whether the expansion valve is regulated correctly. This is the case when there is always liquid showing in the lower liquid gage. The height of the liquid is of no importance as long as it remains on an approximately even level.

Furthermore, the apparatus can be used to ascertain whether the plant is correctly charged. To determine this, the low-pressure side is pumped out and the total charge of the ammonia is liquefied in the condenser. After stopping the compressor, the entire charge is allowed to flow into the expansion coil at a predetermined height of the liquid in the measuring tank.

The author states that tests made with this apparatus show a remarkable correctness for the apparatus, deviating from the calculated refrigerating capacity by but 1 or 2 per cent.

Tilting Bucket Design

Another apparatus for measuring the amount of refrigerant and regulating the refrigerating capacity uses rotating and tilting vessels. One vessel is filled and tilts automatically at a certain measure of liquid when the second vessel is placed under the liquid inlet. The refrigerant from the first vessel flows into a floating vessel and lifts a float valve, so that the accumulated liquid can flow into the expansion coils. The flow of the liquid into the expansion coils cannot go on abruptly, and a special throttling valve is used to retard it. This retarded flow causes an increase in pressure, which is transmitted to a registering mechanism, producing a written record of head and back pressure. Each increase in pressure corresponds to the emptying of one measuring vessel.

The regulation of the circulating refrigerant and, consequently, that of the refrigerating capacity, is done with the help of a floating liquid regulator which allows the passage of only as much refrigerant as is coming from the condenser. It is reported that tests with two different types of this apparatus have been made and that the results have been satisfactory. Measuring instruments of these types are of great value for refrigerating plants, their special importance being to show irregularities in the circulation of the refrigerant.

EDITORIALS

F. R. LOW, *Editor*

High-Pressure Steam in Industry

DURING the last few years considerable has been said about the tendency toward the use of higher steam pressures. It is doubtful, however, if many engineers realize to how great an extent this tendency has progressed in the industrial plant as well as in the central station.

There are at present about sixty boiler installations in this country operating at pressures of three hundred pounds and above. These are divided almost equally between industrial plants and central stations. In Europe an even greater percentage of the high-pressure installations are in industrial plants. The operating pressures range all the way from five hundred to 1,390 pounds, with the majority between three hundred and four hundred.

As most of these plants have been put in operation within the last two or three years, the extent to which high pressures have been accepted can be fully realized. The almost equal division between industrial and central-station plants indicates how closely industry is keeping up with the pace set by the public utility in the field of power-plant design.

The Operator a Factor in Elevator Maintenance

ELEVATOR operators may be a liability or an asset, depending upon their skill and the attention they give to their work. This fact is too frequently overlooked when dealing with this class of employee. What is put in their pay envelopes may be only one of the important items in what they cost to operate the car. The kind of service rendered, the cost for power and maintenance, must also be considered.

An operator that cannot handle the car skillfully cannot render good service. A large part of the power required to operate an elevator is consumed during the periods of acceleration. Making false stops unnecessarily increases the number of starts and increases the power consumption. This also puts exceptionally severe service on the control equipment and increases the maintenance costs.

The operator is also a factor in the life of the cables. This is clearly evident from the increased wear found on elevator cables at the sections that are over the sheaves when the car is stopped at the floor landings. If the car is allowed to go past a floor, is stopped and brought back to the landing, the cables are bent three times, but only once if the car is stopped at the floor at first. A little study of this problem with mileage recorders, stop counters and records of power consumption, may reveal losses that have not been expected and show that some operators are costing much more than appears on the payroll.

Future Development of Power

THE development of power from steam has made rapid progress during the last few years. The theoretical limits of the various known cycles are quite well understood, and it only remains for the engineer to put these cycles to practical use. Even in this application progress has been rapid, and the practical limitations of reheating and regenerative cycles are now becoming more evident. The lower limit of all cycles is the vacuum that may be obtained from the available cooling water, and this cannot be greatly improved over present practice. Further development in the cycle efficiency of steam power plants must lie in the direction of increased initial pressures and temperatures.

The limit appears to have been reached in pressures. An experimental boiler has operated on the Benson system in a German plant at the critical pressure of steam, and there can be little gain in exceeding this pressure. A commercial plant consisting of another boiler, to operate at the critical pressure, together with a turbine and reheaters, will be put into operation within the next few weeks. From this it would appear that the upper limit of pressure for steam has been reached, although the performances that may be expected are not fully known.

Engineers have been reluctant to increase initial steam temperatures with the steels formerly available for fear that these would lose strength at high temperatures. Apparently, they have been conservative in this regard, for there is accumulating evidence that temperatures higher than present practice may be safely used with the steels available. It is significant, however, that several plants have inadvertently operated for appreciable periods at temperatures considerably above what is considered the present safe limit without damage to the turbines or fittings. Alloy steels can be employed that raise the temperature limit for steam to at least one thousand degrees Fahrenheit.

When the pressure and temperature limits are reached for steam, in what direction will engineers turn to improve further the efficiency of power generation from coal? This is an interesting question. It may be possible to employ some other substance in place of, or in conjunction with, steam. Mercury and diphenal oxide have been proposed for this purpose. But here again one encounters the limitations in the strength of metals at high temperatures. There will, no doubt, be further development in this direction.

The losses of the steam cycle as far as the boiler and furnace are concerned have already almost reached a minimum, as witnessed by boiler and furnace efficiencies of 90 per cent and over. The turbine losses are small, and Rankine cycle efficiencies are approaching 90 per cent. A great portion of the heat in the steam is lost in the condenser. Can this be recovered? Bleeding for feed-water heating has effected such a gain. Would it not be proper to save all the heat in the exhaust by utilizing the steam for heating purposes? Some day our large cities may all be heated from our central systems.

The new studies into the structure of the atom and the nature of energy suggest that a more direct way to convert radiant energy of the burning fuel into electrical waves which may be usefully applied, may yet be found. Until such a discovery is made, development will probably follow the lines above indicated toward higher temperatures.

The Rating of Boilers

THE standards by which boilers are rated both here and abroad have always been somewhat arbitrary and hence have formed the subject of much discussion.

The first American standard was the boiler-horsepower fixed by a committee at the Centennial Exhibition, over fifty years ago. This standard was established after tests had been made on steam engines and represented the amount of steam that would develop one horsepower in a reciprocating engine of that day. A later definition of the boiler-horsepower is that it is the equivalent transfer of heat equal to the evaporation of 34.5 pounds of water from and at 212 degrees Fahrenheit.

The weakness of this standard is that the steam consumption of engines has been decreased so that the steam equivalent to a boiler-horsepower will develop several mechanical horsepower. Furthermore, the actual heat transfer in British thermal units equivalent to the boiler-horsepower has been varied by changes in the values of accepted steam tables.

In order to establish a standard that would fairly represent current practice several years ago, American engineers adopted ten square feet of heating surface as equivalent to one boiler-horsepower. This served for a time, but is now rather meaningless, for the application of large areas subjected to radiant heat has made it possible to develop the heat equivalent of ten to twenty boiler-horsepower from ten square feet of heating surface. It will be evident that the square feet of heating surface alone cannot be taken as a measure of boiler capacity, for its heat-absorbing capacity depends on whether it is subjected to the radiant and convection heat of the furnace or only to convection in the last pass of a high boiler.

British and Continental engineers state the capacity of a boiler in the weight of steam per hour that the boiler will develop at its best efficiency and also state the maximum capacity of the boiler. This standard is now open to much question, for it has developed that the best rating and maximum capacity are determined not by the boiler but by the furnace. Increased furnace capacity increases the maximum steaming capacity of the boiler, while better combustion in the furnace increases the boiler output at best efficiency. In other words, the boiler surfaces will transfer all the heat to the water in the boiler that can be delivered to those surfaces. Boiler output is thus largely measured by furnace output.

These comments suggest that there is no standard at present which correctly measures boiler capacity. There is need of a better understanding of this subject, for boilers are now being offered in this country with small heat-absorbing surfaces exposed largely to radiant heat and whose capacity bears little relation to the area of the heating surface, but is depending on the furnace volume and the intensity of combustion.

Pipe Leaks and Corrosion

ONE of the chief causes of annoyance to many engineers in charge of the heating and hot-water plants of large hotels and office buildings are those troubles arising from pipe leaks. While these leaks often require only the tightening of a joint, a more thorough investigation will sometimes disclose that corrosion has been the underlying cause.

It is not surprising that the screwed pipe joints give the first indication of corrosion, as the pipe wall is thinner at the joint and to some extent is subjected to corrosion both inside and outside of the threaded portion. Absence from joint trouble does not, however, mean that corrosion is not taking place.

In pipes carrying water, corrosion is largely due to the presence of oxygen dissolved or entrained. Engineers who are experiencing trouble and those whose troubles from leaks have not yet started, may save themselves and their tenants from annoyance if they will take steps to eliminate as much of the oxygen as possible from the hot water before sending it through the building. In doing this they will in general retard corrosion, and leaks will take care of themselves.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Why the Engine Speed Dropped to 50 per cent of Normal

AS A regular reader of *Power* it occurred to me that the following report of an experience I met with in the course of my duties as engineer surveyor might be of interest to other readers, not so much as to the remedy, but as to the cause of the slowing of the engine speed.

A horizontal cross-compound engine having cylinders 18 and 32 in. in diameter, 5-ft. stroke and running 120 r.p.m., taking steam at 120 lb., was regularly surveyed

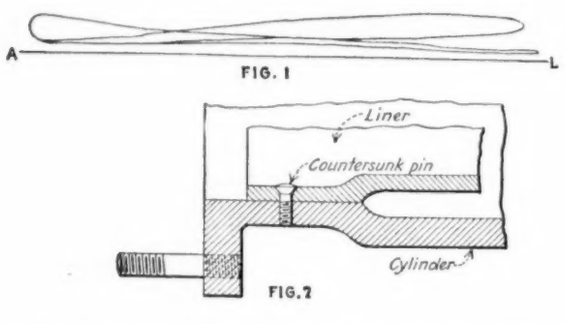


Fig. 1—Diagram from low-pressure engine. Fig. 2—Shows how cylinder liner was fastened in position.

by me. On one occasion, when calling at the plant to make my usual inspection of the engine, I noticed that the speed was considerably reduced. The engineer informed me that the speed of the engine had been dropping about 10 revolutions a day for nearly a week without any apparent cause and that for three nights previous to my visit he had taken all the valve gear down, examined the valves and settings, and had put in two new valves on the exhaust side of the high-pressure engine.

I decided to indicate the engine at once and examine the diagrams, as the steam pressure seemed all right. The high-pressure diagram was satisfactory except that the back pressure was excessive for such running. I questioned the engineer as to his valve setting and he was positive that the setting was correct. When I asked him if he was sure that the spindles were not twisted, he requested that I examine them myself, which I did and found them correct. Upon indicating the low-pressure engine, I obtained the diagram shown in Fig. 1, which could hardly be described as a diagram, as the steam pressure entering the cylinder showed about 8 lb., whereas the back pressure in the high-pressure cylinder was about 40 pounds.

The diagrams showed that there was evidently a stoppage in the exhaust passage between the high- and low-pressure cylinders. As the valve setting on the engine was apparently correct, I decided to link up the low-pressure engine until the trip gear began to miss. This made practically no change in the diagrams. Finally I came to the conclusion that there was something wrong in the exhaust or steam ports of the low-pressure engine and requested the removal of the cover to examine these ports from the cylinder side. When this was done it was discovered that the low-pressure cylinder liner had turned round in the cylinder for a length of no less than $12\frac{1}{2}$ in., leaving a steam port opening of only $1\frac{3}{4}$ sq.in., whereas this was originally about 14 in. long and $1\frac{3}{4}$ in. wide. There was nothing to do but remove the liner, which, strange to say, was a most difficult job, as it was found to be set fast in its new position and the cylinder had cooled down considerably since stopping. When the liner had been replaced, it was fastened in position by inserting $\frac{7}{8}$-in. screwed pins as shown in Fig. 2. Needless to say, there has been experienced no further trouble with the engine.

J. CASSIDY.

Birmingham, England.

Operation of Three-Phase Motor Single-Phase

SOME TIME ago the author was called upon to solve the problem of an unbalanced current reading on two power transformers, which finally terminated in locating a three-phase motor operating single-phase. It also

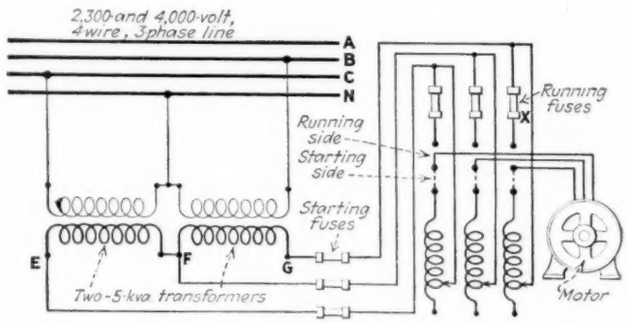


Diagram of motor and transformer connections

proves that periodic transformer tests are worth something besides load determination.

The circuit was as shown in the figure and consisted of two 5-kva. transformers connected open-delta, feeding power service. One of the loads on this line was a 5-hp. three-phase 220-volt motor. The motor was started by a double-throw switch having a set of com-

pensating coils and provided with starting and running fuses.

The test report came through showing heavy current readings taken at *E* and *F* and zero at *G*. From the office it appeared that possibly there was some trouble with the transformer or wires, and an inspection was made in the field. The owner advised that the motor started and ran satisfactorily as far as he knew, but on further investigation it was found that it made more noise when several machines were in operation.

A test made on the starting fuses proved them to be complete. If one of the starting fuses had blown, the motor would have failed to start and would have been remedied immediately.

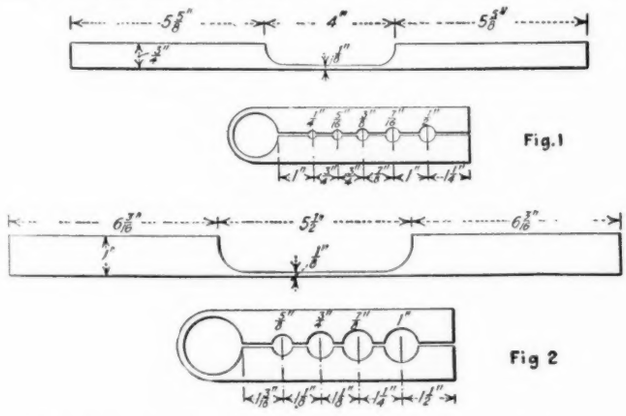
When the running fuses were checked, it was found that the fuse marked *X* was blown. This fuse was replaced, and balanced current readings were again obtained on both transformers. Fortunately, the motor had been operating with a light load, otherwise it might have been burned out by overloading one phase.

Flushing, N. Y. MAURICE D. SMITH.

A Practical Stud Holder

THE illustration shows a handy tool that has been in use for several years for holding studs and screws for cutting and fitting, also for holding studs from which nuts have to be removed. One holder will conveniently hold studs from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. diameter inclusive, and another can be made to hold studs from $\frac{5}{8}$ in. to 1 in. inclusive.

The holders can be made of key stock or tool steel; the former will give considerable service, but the latter has of course better wearing qualities. To make the $\frac{1}{4}$- to $\frac{1}{2}$-in. holder, a piece of $\frac{3}{4}$-in. square steel is necessary, shaped or forged as Fig. 1. It is then heated at



Details and dimensions of holders for studs from $\frac{1}{4}$ to 1 in. diameter

the center and bent as shown. A sheet-steel liner $\frac{1}{32}$ in. thick and $\frac{3}{4}$ in. wide is placed between the legs and the whole clamped in the drill vise. It is now marked off and then drilled and tapped. After tapping, the $\frac{1}{32}$-in. liner is removed and the tool is ready for use.

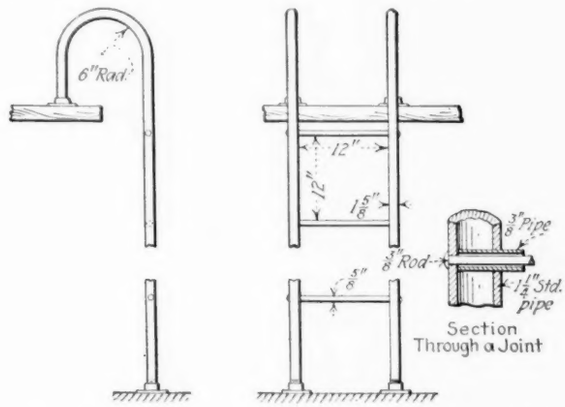
To make the $\frac{5}{8}$-in. to 1-in. holder a piece of 1-in. square steel about 18 in. long is shaped as in Fig. 2 and then bent and marked off for drilling and tapping, using a liner $\frac{1}{16}$ in. thick between the legs.

Long Beach, Calif. E. J. JORDAN.

Practical Type of Metal Ladder

THE ladder illustrated herewith is popular with the personnel of the power plant where it is used, because it combines neat appearance with comfortable touch and it is fully as rigid as ladders of the flat-bar type. It is simple to make, whether done outside the plant or with the shop facilities at hand.

The two sides are made of $1\frac{1}{4}$-in. pipe. This is large enough to drill safely for the rungs and small enough to be grasped in the hands. The ends are threaded or not,



Details of ladder made from standard iron pipe

according to the style of fastening; if ends are to be set in concrete, they are left plain—if they are to be bolted fast, they are threaded. Threading the ends and fastening by means of floor flanges is a cheap and substantial method and has the advantage of easy removal if a change is necessary.

Sides that rise above the upper platform are a convenience and safety feature that should not be overlooked. They are simply made, as will be explained. Sufficient length of pipe for the bend having been allowed, both ends are threaded and a cap screwed on one end. Then the pipe is filled with sand which is rammed tight. When full, a cap is screwed on the other end. The pipe is heated red by any convenient means and bent, using a vise, horn of an anvil, floor plugs or structural members to hold the free end during the process. When bent, the sand is extracted and the flanges screwed on.

Standard $1\frac{1}{4}$-in. iron pipe is about $1\frac{5}{8}$ in. O.D. and $\frac{3}{8}$-in. pipe is about $\frac{5}{8}$ in. O.D. Rungs made of $\frac{3}{8}$-in. pipe may be let into the larger size. Where the diameters are too close, the larger pipe is materially weakened and it is hard to drill it centrally. These ladders have pipe rungs that pass through the inner wall of the side pipes and butt against the outer. Every second rung has a $\frac{3}{8}$-in. rod through it, with the rod riveted down on the outside to a round head as shown in the detail at the right of the illustration.

These ladders may be made in widths and rung spacings to suit individual needs. They are as cheap as the flat-side type because the latter require rungs turned with shoulders on them. In appearance and comfort the pipe ladder is superior—it is one type of pipe construction that doesn't look as if it had been made in a plumber's shop, because tees and elbows and nipples are not used. D. A. HAMPSON.

Middletown, N. Y.

COMMENTS *from* READERS

The Work Habit

A SHORT time ago I dropped in to see Bill, the chief of the "X" power plant and found him buried in the pages of Aug. 16 *Power*. After the jimmy pipes were properly stoked up and combustion progressing nicely, Bill passed *Power* over to me and asked if I had read Editor Low's Foreword, "The Work Habit." I replied that I had and thought it good and along the right lines.

"Well," said Bill, "as a general thing Mr. Low hits the nail on the head, but when he speaks of bulldog tenacity in overcoming the inertia of the average power-plant owner, he certainly does not speak from actual experience, or he would know that the aforesaid inertia of the party of the first part follows Newton's first law of motion and remains at a complete rest as far as the power plant is concerned, and that it would take the concentrated tenacity of several bulldogs to overcome it and get it started in motion, and then nine times in ten it will meet with an equal reaction that will bring it back to a state of rest.

"This is true only as far as the power plant is concerned. The factory will get all kinds of modern machinery that will reduce costs and increase production, but if you mention the power plant to the boss, he goes on the dead center and the gage registers a complete vacuum.

"Oh, yes! I know what you are going to say—present the proposition in a business-like manner for he can only understand things that are put in front of him in a business-like way, etc. But there are conditions in every plant that are wasteful, and without the proper means you cannot put them to the front in a business-like manner or state them in dollars and cents. You know that the Boss's money is going up the chimney and in various other ways. You cite other plants that have saved money by putting in modern equipment and instruments, but he comes back at you for a guarantee of the amount that can be saved, and if you do get him in motion and you get one improvement, he expects it to be a 'cure all' and cover all the sins of the plant. You plug one leak, but the others go right on at the same old stand. And if the one little improvement that you do get does not come up to his expectations, his inertia jumps back into full gear and you have to sick on your bulldogs with all their tenacity to move the inertia into action again.

"Don't get the idea that my boss is any worse than others. He is just the average owner—one of those that cannot understand the power plant and to whom combustion is a mystery and only means the steam to move the factory wheels, that spend thousands to equip the factory end with modern machinery and the office with modern accounting systems and machines and that rely on their bookkeepers' statements, although they know no more of the details of it than they do of the power plant.

"Just why this is so I cannot say, but maybe some day they will realize that instruments in the power plant are more valuable than adding machines in the office. The plant's instruments will show the losses and where they are and point out the way to stop them, while the adding machines and the bookkeeper can only show that they are present, but are unable to tell where or how to prevent them.

It is hard to understand just why this inertia is present in the average plant owner's mind, when the power house is the heart and lungs of his business.

Wilkes-Barre, Pa. THOMAS M. STREET.

* * *

How Would You Do It?

REFERRING to the inquiry of Ronald Simmons in the Aug. 9 issue as to the best method of razing a chimney, we had a similar problem at our plant some time ago except that the chimney was 100 ft. high and 42 in. in diameter. We removed it by felling, and we had no difficulty in having it fall just where we planned to have it. Our stack rested on a cast-iron base so that it was unnecessary to do any cutting at the base, but I believe that if Mr. Simmons will follow our method he will have no trouble.

First some heavy blocking should be laid on each side of the stack parallel to the direction in which the chimney is to fall. When this blocking is about 2 ft. high, two heavy pieces are laid across the top on each side of the chimney at right angles to the first blocking. The two pieces on each side are securely bolted together and then they are bolted to the chimney by means of long rods. By placing a couple of jacks on one side of the chimney under one of the bolted pieces, the pieces on the other side will serve as a shaft for the chimney to turn on and tend to keep it from going sideways in falling. If it is necessary to cut the chimney at the base with a torch, it should be cut below the bolted pieces and the jacks will help to support it until it is ready to fall.

After the blocking is placed at the base and before any cutting is done, attention should be given the guy wires or chimney stays. Fasten a strong rope securely to each of the stays *B*, *C* and *D* above the turnbuckle and bring the other end of each rope through the eye of the anchor bolt and make fast. It will not be necessary to touch stay *A*. After the ropes have been fastened to the stays as directed, remove the turnbuckles and let the ropes take the strain. After removing the turnbuckles on stays *C* and *D*, place a piece of blocking under the rope so that a man with a sharp ax can cut the rope with one blow. Next fasten a strong rope to the middle of stay *A* and run the rope through a single-pass block, fastened to the ground directly underneath, and attach it to a heavy auto truck. Next station a man with a sharp ax at the

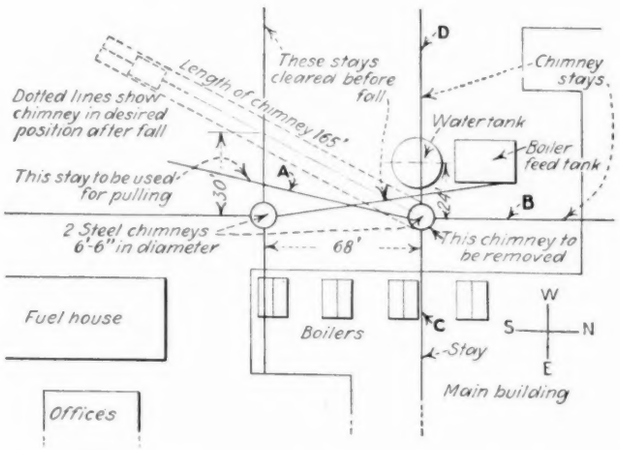
end of stay *C* and designate him No. 1, and another man at the end of stay *D* with a sharp ax and call him No. 2. The person in charge of the job should take his position directly opposite the side of the chimney on which it is desired it should fall. We are now ready to fell the chimney.

First put a good load on the jacks. Next cut the chimney with the torch as much as possible and have it remain in place. Start the truck and slowly tighten stay *A* and at the same time, men stationed at the end of stay *B* should free it entirely. Continue pulling slowly with the truck until the chimney starts to fall toward stay *A;* immediately the foreman should cry out "No. 1," which should be the signal for the man at the end of stay *C* to cut the rope with the ax. The chimney will continue to fall toward stay *A* but stay *D,* which is still fastened, will not be long enough to allow it to go in that direction, so the chimney, which is still falling, will swerve in the direction of stay *D*. When in the judgment of the foreman the chimney has swung over to the point where he wishes it to fall vertically, he will cry out "No. 2" and the man stationed at the end of stay *D* will cut the rope and stop any further pulling in that direction, and it will fall where he wished. Of course the auto truck has been pulling on the stack and getting out of the way in the meantime.

There are some precautions that should be observed, or trouble is likely to result.

1. Make sure that the blocking at the base is securely bolted to the chimney.

2. Be sure that the ropes that replace the turnbuckles on the stays are large enough and that they will not slip,



Plan showing position of chimney and desired line of fall as given by Mr. Simmons

especially on stay *D,* the pull on the chimney by this stay being the only thing that keeps it from going into the other stack.

3. Place only reliable men at the ends of stays *C* and *D,* where the cutting is to be done. Be sure that they understand their signals and that they will obey instantly and that the man at the end of stay *D* will not cut his rope when he hears the order for the man on stay *C* to act.

4. After the chimney begins to fall, the foreman should not take his eye off it for any reason whatever until he has given orders for the man at stay *D* to cut it loose.

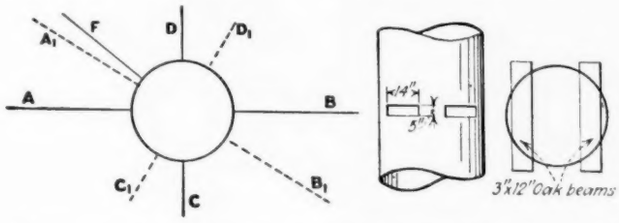
5. Give all orders clearly and distinctly and do not get excited.

BURTON W. WHEELER.

Rockland, Mass.

AS I have removed several chimneys with success, I thought my method might be of interest.

Referring to the illustration, take loose guys *A, B, C* and *D,* and fasten them as shown by the dotted lines marked *A, B, C* and *D*. Line *F* represents the desired line of fall. Each guy must be cut and securely fastened



Shows rearrangement of guys and method of supporting

before cutting another. Guy *A* is lengthened and run through a snatch block and fastened to a motor truck.

Next burn four holes in the stack, as shown at the right in the illustration, at the height at which it is to be cut. These holes are to be 5x14 in. and should be cut opposite each other. In these holes place 3x12-in. oak timbers of sufficient length to project 6 or 8 in. on each side of the stack and wedge them tight on the top with oak wedges. The holes are cut so that the timbers will be parallel with the line on which the stack is to fall.

Now cut the stack all the way around with the torch and it will rest securely on the wedges. Have a man ready to cut guy *B* with bolt cutters as soon as the truck starts pulling, which will cause stack to fall where planned.

On stacks with more than one row of guys I simply cut all but one row loose.

E. AAGAARD.

Nitrate, Ala.

* * * *

Burning Culm

IN THE Aug. 30 issue of *Power* there appears in large type "Stanton Base-Load Plant Burning Culm." Again, "The successful burning of anthracite culm which for years has been discarded as waste material." "About one-fifth of the culm will pass through a $\frac{3}{16}$-in. screen," etc.

What is culm and what is the real status of these piles of waste material?

Culm is recognized in different localities as small anthracite which is too fine to pass as market size coal. No. 3 buckwheat, the smallest size market anthracite, is through $\frac{5}{32}$ in. and over $\frac{3}{32}$ in. Therefore culm must be through $\frac{3}{32}$ in. At Stanton "About one-fifth of the culm passes through $\frac{3}{16}$-in. screen." This cannot be waste fuel or culm when there is a large demand for No. 2 and No. 3 buckwheat, and today there are thousands of washeries reclaiming this size coal from the waste banks and selling it at a good profit.

You would not publish an article of a plant burning crude oil because crude oil is too valuable to burn under boilers. So is No. 2 and No. 3 of the mine plant when

there are millions of tons of fuel of no market value at hand.

Anthracite is mixed and then prepared. All lumps too large for market are sent through crushers. Much fine coal is produced by this crushing process. All the coal then passes over screens with water playing on them. These screens are perforated with holes of size to suite market sizes. The fine coal keeps dropping from one large screen to the next smaller screen till it reaches a screen through which it cannot pass, but shakes over the end into chutes. This sized coal then goes to jigs of varied types, all of which tend to eliminate a large percentage of slate, rock or ash. The finest coal, a "culm," passes out and is either run into the river or run onto waste banks. It does not go through a jig and therefore is high in ash.

The culm contains from 20 to 30 per cent ash from 9,000 to 9,800 B.t.u. per pound. This fuel was tried at Stanton and discarded. The design of the Stanton Station is not proper for this grade of fuel. Many of the refinements at Stanton would prove uneconomical if the boiler house had been laid out for this fuel. Why? Because this fuel sells for 50 cents a ton where Stanton today burns $2 coal.

The Susquehanna Collieries for the last three years have made five million pounds of steam per day using this fuel. From analysis at hand I quote: Moisture, 14.33 per cent as received; volatile, 6.43 per cent; culm, 70.57 per cent; ash, 22.98 per cent. Through $\frac{3}{32}$ in., 75.4 per cent. B.t.u., 9,715.

This boiler house had no collection of high-priced refinements for saving coal. Some improvements would no doubt be economical. However, the reduction of fuel cost from $2 a ton to 50c. a ton made such an enormous saving that none of the officials are interested in the cost of coal or in saving it either.

JAMES H. KEENAN, Chief Engineer,
No. 7 Colliery, Susquehanna Collieries Co.
Nanticoke, Pa.

* * * *

An Engineer Would Stop an Oil Engine In a Different Way

REFERRING to Question 4 of "What do you know?" in the issue of Sept. 13, I cannot agree with the answer given.

What will happen when an engine is started with the injection air line flooded with fuel oil and the injection air turned on is not answered in a few words. It will depend on the grade of fuel oil used, the design of the starting gear and whether the engine is hot or cold.

Let us assume that the engine is cold, as it would be after a night's standing, a fuel oil of 24 to 30 deg. Bé., the engine so designed that starting air is admitted to all cylinders, and, after the engine has gathered momentum, the camshaft is shifted to running position, which disengages the starting-valve levers and brings the fuel-valve levers into action.

The fuel oil depends on the injection air for proper atomization. As no air enters the spray valve, the fuel oil will not be in a condition to ignite and most of the oil in the air line will escape through the exhaust valves in an unburnt state. As the momentum of the engines decreases rapidly, the start under these conditions will be lost. The camshaft will have to be shifted back to starting position before the engine stops and starting air again admitted. Cylinder walls and pistons have now attained some temperature, and when the camshaft is moved to running position, the fuel oil, when entering the cylinders, will explode, as frequently happens at a start when the engine is too generously primed. If the relief valves cannot take care of these explosions, the engine will be wrecked before it comes to normal speed.

Let us assume a second case, with the condition of engine and fuel oil as before. Starting air is admitted to half the number of cylinders. Fuel oil enters the other cylinders from the moment the engine begins to turn over. As this is only slowly in the beginning, the fuel valves are held open for a greater length of time and, consequently, a larger amount of fuel oil is delivered to the cylinders and will leave unburnt through the exhaust valves. Unless the air line is very large, the chances are that it will be cleared of all fuel oil in this manner. If not, a cylinder explosion is likely to occur before the engine has attained full speed.

Where very heavy oil (19 to 21 deg. Bé.) is used while running, a light gas oil or, in some cases, kerosene is used for starting. These oils will ignite more readily even though poorly atomized, and a cylinder explosion with disastrous results will be inevitable. The same will be true when the engine is started hot.

Let us now assume that the engine does withstand the strain and that it does overspeed. As the quickest way to stop it, it is suggested to "hang open the exhaust valves and open the spray-valve bleeder cocks," which latter, I presume, are identical with the fuel bypass valves. No doubt the engine will stop quickly if this is done, but the question is, Can it be done in actual practice?

I am acquainted with quite a number of designs of oil engines, domestic and foreign, but I have yet to come across one that provides ready means whereby the exhaust valves can be locked open instantaneously and simultaneously, while running. Consequently, the engineer who finds himself in such a precarious situation, will have to hunt for suitable material to block the valves open. The chances are that there will not be much left of the engine by the time he returns to it.

I also fail to see what good it will do to open the fuel bypass valves under these circumstances. Fuel lines and air lines connect in the spray valve and are separated from each other by a check in the fuel line. Unless the helper left the checks out, the opening of the bypass will only prevent the fuel, delivered from the fuel pump, from entering the cylinder, which fuel is already cut off by the governor, as the engine is overspeeding, but the oil in the air line will still be retained.

The quickest way to stop the engine, as I see it, would be, in case 1, to shift the camshaft to starting position, which will close the spray, or fuel, valves immediately, and in case 2 to open the high-pressure drain at the air compressor and the injection-air pressure will drop below the compression in the cylinders within two or three revolutions.

Branford, Conn. GEORGE C. W. GOLEM.

[The conditions outlined in the question and answer actually occurred. It is, of course, understood that no answer will apply to all engines and that there are other methods of meeting the situation, depending upon the engine design.—Editor.]

New and Improved EQUIPMENT

Improved Morse Type 55 Silent Chain

A CHANGE in the design of the rocker joint with a view to increasing the strength and running qualities of the chain is included in the improvements recently made to Morse Silent Chain, manufactured by the Morse Chain Co., Ithaca, N. Y.

Referring to Figs. 1 and 2, which show the standard and improved joints,

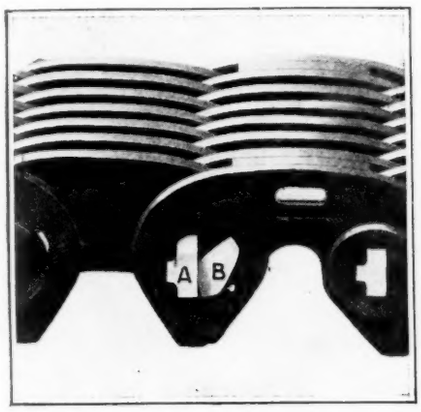


Fig. 1—Standard Morse chain joint

respectively, the seat pin *A* has been enlarged to give greater bearing surface and give it additional transverse strength. The rocker pin *B* has been changed in contour to give a better surface contact with the links. The

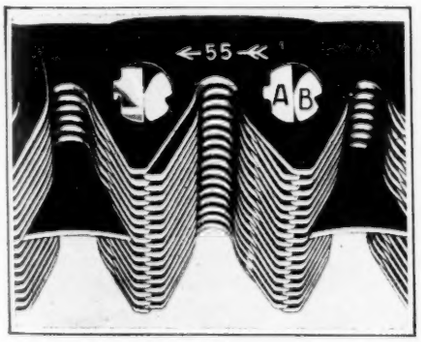
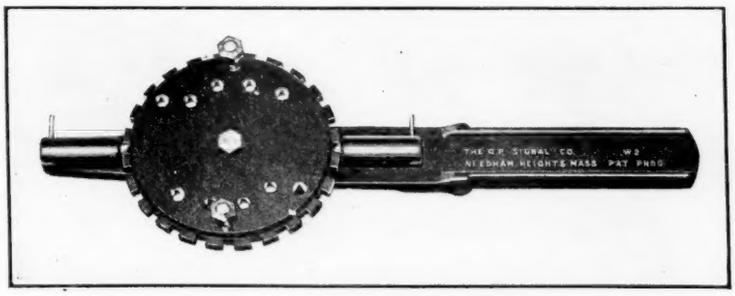


Fig. 2—Improved Type 55 chain

new chain will run in all standard sprockets.

It is claimed by the manufacturer that the improvements have produced a better balanced joint and a smoother running chain, also that the breaking strength is increased about 50 per cent.



Ratchet flange wrench for pipe sizes from 2½ to 8 inches

Q-P. Ratchet Flange Wrench

TO FACILITATE the installation and removal of pipe flanges the Q-P. Signal Co., Needham Heights, Mass., has brought out the ratchet flange wrench shown in the illustration. The disk of the wrench is bolted to the flange and the turning effort is secured through two ratchets mounted on the handle. The end of the handle is so shaped that a piece of pipe can be slipped over it for extra purchase if necessary. The ratchets are reversible so that the flange can be turned either way with the same movement of the handle. The short-movement ratchet feature is of particular advantage where the working space is limited.

The wrench is made in two sizes, number 10 and 11. The number 10 wrench is suitable for 2½, 3 and 4 in. standard and extra heavy flanges and number 11 for 4, 6 and 8 in. sizes.

Nicholson Improved Flexible Coupling

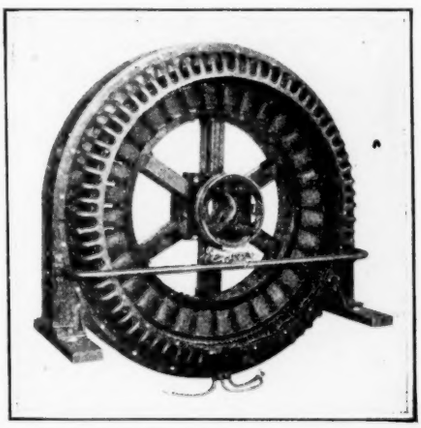
RECENT improvements made to the flexible coupling manufactured by the W. H. Nicholson Co., Wilkes-Barre, Pa., and described in the Dec. 23, 1926 issue, include changes in certain parts of the coupling to give it a greater oil carrying capacity.

In the improved coupling, which is known as style *A*, holes are drilled longitudinally through the floating keys and hubs to act as oil reservoirs. A lip is also extended from the casing over one hub of the coupling, to permit oiling with the coupling in motion.

This improved coupling, it is claimed, has 150 per cent more oil carrying capacity than the former type and a better oil cushioning effect is obtained between the driving parts.

Westinghouse Synchronous Motor of Welded Construction

A NEW low-speed synchronous motor called the type "HR" has been introduced by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The company states that while arc welding has been used to some extent in its motors for fifteen



Motor of welded construction

years, it reaches its greatest application in this motor.

A starting torque of 50 per cent and a pull-in torque of 40 per cent are characteristic of this new motor. Provision for varying the flywheel effect is provided by means of different weight rings bolted to the rim. Six possible values of flywheel effect are available. The shape of the rotor arms is such that a large amount of air is set in motion. This cooling air is so directed that it passes not only through the stator coils, but also over a large area of the laminations of the stator.

Peabody "Toronto" Pulverized-Coal Burner

WITH a view to reducing the number of pulverized-coal burners and consequently the number of feeders required to fire boilers of large capacity, the Peabody Engineering Co., 110 East 42nd St., New York, has developed the

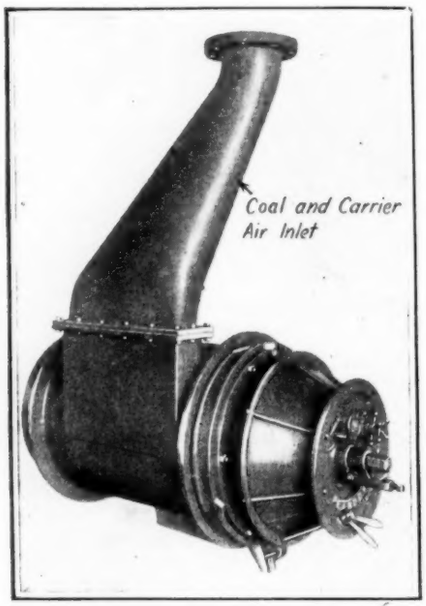


Fig. 1—Assembled view of burner

burner illustrated herewith. Fig. 1 shows an assembled view of the burner and Fig. 2 a longitudinal cross-section.

The burner, which is known as the "Toronto type," is designed for a capacity of 8,000 lb. of coal per hour and to operate at maximum capacity with low secondary air pressure. As will be apparent from the illustrations, the coal and primary or carrier air is introduced tangentially through a large rectangular inlet into a screw-thread-vaned burner body. The function of the vanes is to give the coal and air a definite whirling action and an even distribution into the secondary air, which is admitted through the center of the burner.

To give the secondary air a whirling motion, at the inlet to the burner, in the same direction as the coal and primary air, the standard air register used on the Peabody combined gas and oil burner is retained, together with a curved-blade section *A* incorporated between the air register and the burner.

It is claimed that the effect of the finely divided streams of coal produced by the screw-thread vanes is to give a highly turbulent action, upon combining with the secondary air and to obviate stratification in the burning zone.

The burner is adaptable for use with any type of unit pulverizer or any type of feeder from a bin system.

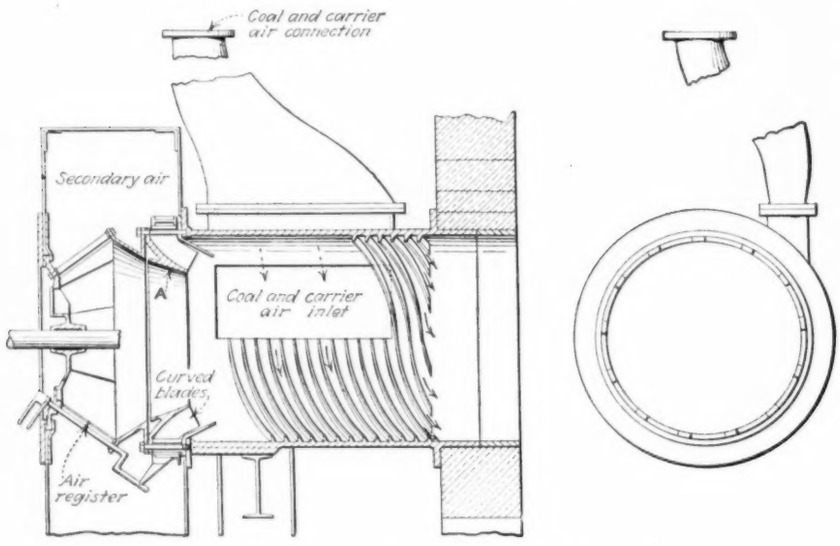


Fig. 2—Cross-section showing screw-thread-vaned burner

Link-Belt "Sykes" Herringbone Speed Reducer

THE Link Belt Co., Chicago, has recently added to its line of power-transmission equipment the Sykes herringbone reducer, two types of which are illustrated herewith.

The reducer is made in three standard units designed to cover a wide range of ratios and capacities. Type S, a single-reduction unit, covers ratios up to 10 to 1. Type D, a double-reduction unit, is designed for heavy duty and designed for both light and heavy duty.

The herringbone gears, which are of high-carbon steel, are made with continuous teeth across the face of the gear. The pinions are of heat-treated alloy steel with the teeth cut integral with the shaft. Double oversize ball

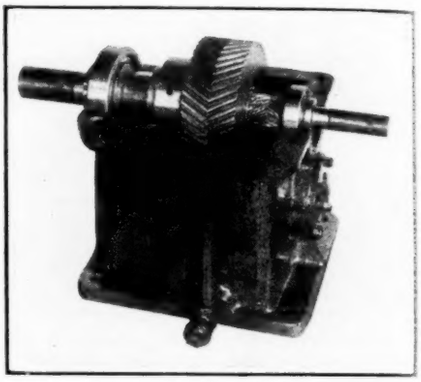


Fig. 1—Type DV double-reduction unit for light duty

bearings are used throughout to take care of any thrust and overhung loads which the unit might be subjected to in service. All bearings are splash lubricated, and special oil baffles are provided at the shaft projections to prevent loss of oil. No oil grooves or oil wipes are used.

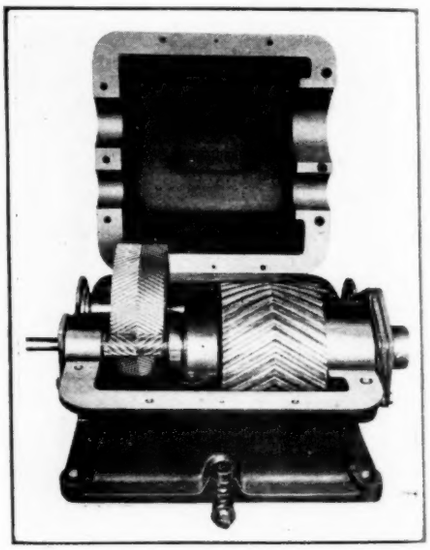


Fig. 2—Type D double-reduction unit for heavy duty

ratios from 10 to 1 up to 80 to 1. Type DV is a light-duty double-reduction unit with ratios ranging from 10 to 1 up to 130 to 1. The type S unit is

Burt Fan Ventilator

THE Burt Mfg. Co., Akron, Ohio, has recently added to its line of ventilators a unit of the fan type, consisting of a cone damper ventilator (described in the April 20, 1926, issue) with a motor-driven propeller-type fan mounted in the air shaft. The motor has a ball bearing and is specially mounted to eliminate vibration.

NEWS *of the* FIELD

Stoker Manufacturers Discuss Betterment of Industry

The fall meeting of the American Stoker Manufacturers' Association convened at Shawnee-on-Delaware, Pa., September 26, 27 and 28.

Following the address of President R. B. Mildon, general manager of the stoker department of the Westinghouse Electric & Manufacturing Co., reports of the secretary and treasurer and matters of common interest to those engaged in the manufacture and sale of mechanical stokers were discussed in detail, and a free expression of opinion was exchanged with regard to future activities and procedure.

Announcement was made of the admittance of Flynn & Emrich Co., manufacturers of the Huber stokers, Baltimore, to the Association's membership.

On the entertainment side of the program full advantage was taken of the excellent golf course of the Shawnee Country Club, the hospitable service of the Buckwood Inn and the exceptionally fine September weather.

On Monday evening, September 26, films provided by Stone & Webster, Inc., Riley Stoker Corp., Westinghouse Electric & Manufacturing Co., were exhibited and discussed.

At the banquet on Tuesday evening, W. H. Rastall, chief of the industrial machinery division of the Department of Commerce, explained the desire and intention of the Department to extend the service which it is rendering to foreign commerce and to domestic industries. Following this address an interesting consideration took place on the question of possible aid to the American machine industry in general and to stoker manufacturing interests in particular.

A liberal distribution of prizes for prowess upon the golf links was a feature of the dinner.

New York Utilities Apply for Consolidation

Joint petition was filed September 28 with the New York Public Service Commission by the Niagara, Lockport & Ontario Power Co. and the Western New York Utilities Co., Inc., the latter serving electricity in Batavia, Albion, Medina, Brockport and various towns in Erie, Genesee, Monroe, Niagara, Orleans and Wyoming Counties, for permission to consolidate into a single corporation under the name of the Niagara, Lockport & Ontario Power Company.

The petition states that the consolidation will make for efficiency in service and facilitate operation of the properties as an entirety and no financing is necessary to provide for additions, betterments and extensions. It is also stated that the outstanding common stock of the two companies is now owned by the Buffalo, Niagara & Eastern Power Corporation.

Boiler Code Committee Honors C. W. Obert, Past Secretary

As an expression of appreciation of the valuable service rendered the Boiler Code Committee of the American Society of Mechanical Engineers by Casin W. Obert, whose retirement as secretary to the Committee took effect June 24, the presentation of a handsome gold watch was tendered Mr. Obert by Charles L. Huston at the meeting of September 16.

At the time of Mr. Obert's resignation the members of the original Boiler Code Committee, with Mr. Huston as chairman, were appointed to draw up resolutions expressive of the "appreciation of the Committee of the splendid work done by Secretary Obert." These resolutions were subsequently presented to the Council of the A.S.M.E., and Mr. Obert was made honorary secretary of the Committee.

Burton Plant of the Georgia Power Co. Opens Up

Operation of the Burton hydro-electric plant of the Georgia Power Co. got underway September 15.

With the completion of the power house early in September, the Burton plant became the final link in the chain of six major hydro-electric developments on the Tallulah, Tugalo and Chattooga Rivers.

The Burton plant, which is at the base of the Burton dam, has a generating capacity of 12,000 hp. It was completed and successfully tested September 7. The plant will have an annual output of 23,500,000 kilowatt-hours.

There are two generators at the Burton plant, which will be active when the water is released from the big reservoir. Although the plant will not be considered a reserve plant, it will be in operation only as the water in Lake Burton is needed in the lakes lower down in the chain, or in case of an extraordinary demand for power.

Electrotechnical Men Honor Volta, Meet Mussolini

At the plenary session of the International Electrotechnical Commission held at the Real Accademia de Lincei, Rome, September 22, the reports of the advisory committees were accepted unanimously. The new president, Dr. Clarence Feldmann, of Holland, made a short inaugural address, praising the work accomplished during the Semenza administration and asking continued support and harmonious international co-operation.

It was announced that the commission had agreed to co-operate to some extent in certain phases of the work of the League of Nations. Denmark, Sweden and Norway united in inviting the commission to meet in Scandanavia in 1930, and as reported last week, the invitation was accepted.

During the commemoration of the one hundredth anniversary of Volta's death, held at Como, Prof. A. E. Kennelly, of Harvard University, responded to an address by the Mayor and in doing so announced the completion of an endowment fund of $25,000 raised in the United States to pay the expenses of one Italian student each year at an American university. Maurice A. Oudin, vice-president International Electric Co., and John W. Lieb, vice-president New York Edison Co., are active supporters of this plan and cabled news of its success.

The delegates also participated in a meeting held at Rome in the hall of the Italian Senate in memory of Volta, when Marconi spoke.

Premier Mussolini received them in the Villa Torlonia September 20, and in Bellagio, Como, Milan, Venice, Florence, Rome, Pisa, Genoa and Turin, the local authorities and electric societies showed them many courtesies. A special train was placed at their disposal by the government.

Pennsylvania Gas Get Control Of American Electric

The Pennsylvania Gas & Electric Corp. has acquired control of the American Electric Power Co. from the American Gas & Electric Co. The two former companies will be controlled by the recently formed American Electric Power Corp. Public financing is expected to result from the merger.

The acquired company controls utilities in and near Wilmington, Del., and Springfield and Dayton, Ohio. Local managements of its subsidiaries will remain unchanged.

Fuels Meeting Next Week Slates Big Program

At the first National Fuels Meeting, which will sit in a number of important sessions on fuel studies and applications at the Hotel Stattler, St. Louis, Mo., October 10-13, an imposing list of fuel experts and engineers will participate in the program.

Papers dealing with more general considerations included an "Address on Fuels"—Prof. S. W. Parr, professor of Applied Chemistry, University of Illinois; "American Fuel Resources"—O. P. Hood, chief mechanical engineer U. S. Bureau of Mines; "Combustion and Heat Transfer"—Prof. R. T. Haslam, and H. C. Hottel, Massachusetts Institute of Technology; "The Clinkering of Coal Ash"—A. C. Fieldner, chief engineer of Experiment Stations, U. S. Bureau of Mines, Pittsburgh, Pa.; "Factors Governing the Purchase of Fuels"—Morgan B. Smith, engineer, General Motors Corp.; "Refractories for High Temperatures" — Stewart Phelps, director of research and tests, American Refractories Institute Fellowship, Mellon Institute; "Coal Mining and Coal Preparation from Standpoint of Quality," and "Recent Developments in Low Temperature Coal Carbonization"—H. D. Savage, vice-president Combustion Engineering Corp.

Industrial Studies

Seven papers will cover industrial problems:

"Industrial Applications of Heat"—W. Trinks, professor of mechanical engineering, Carnegie Institute of Technology; "Progress in Gas Producer Practice"—W. B. Chapman, president, Chapman Engineering Co.; "Application of Powdered Fuel to Smaller Boiler and Industrial Installations"—H. W. Brooks, consulting engineer, Erie City Iron Works; "Rotary and Vertical Kilns for Cement, Lime and Gypsum," "The Use of Fuels in Brick Kilns"—W. E. Rice, assistant fuel engineer, U. S. Bureau of Mines; "The Burning of Liquid Fuels"—Ernest H. Peabody, president, Peabody Engineering Corp., and "The Relative Values of Gaseous, Liquid and Solid Fuels"—F. C. Binnall, assistant manager, Standard Sanitary Manufacturing Co., New Brighton, Pa., formerly chemical engineer, General Oil and Gas Corporation.

Papers On Power Plant Fuel Problems

Fuel in connection with power plant operation will be treated in "Characteristics of Modern Boilers"—E. R. Fish, vice-president, Heine Boiler Co.; "Characteristics of Modern Stokers"—F. H. Daniels, president, Riley Stoker Co.; "Air Preheaters"—Frank M. Van Deventer, special engineer Henry L. Doherty Co.; "Direct Fired Powdered Fuel Boilers with Well Type Furnaces at Charles R. Huntly Station"—H. M. Cushing, chief engineer, Buffalo General Electric Co., and "Automatic Combustion Control"—J. A. Peebles, chief engineer, Hagan Corporation.

Smoke Abatement

This problem will have special treatment in "The Measurement of Atmospheric Smoke Pollution, Visible and Invisible"—Dr. Geo. T. Moore, director, Missouri Botanical Garden; "Smoke Abatement Methods Used in Cleveland"—Col. Elliott H. Whitlock, commissioner of smoke inspection, Cleveland, O.; "Managing a Smoke Abatement Campaign"—Erle Ormsby, president, Citizens' Smoke Abatement League, St. Louis, Mo.; "Furnace Essentials for Smokelessness"—H. B. Meller, chief, Bureau of Smoke Regulation, Pittsburgh; "Smokeless and Efficient Firing of Domestic Furnaces"—Victor J. Azbe, consulting engineer, St Louis; "The Effect of Atmospheric Smoke Pollution,—a Summary of Opinions from Current Literature"—Prof. A. S. Langsdorf, director of industrial and engineering research, Washington University, St. Louis, Mo.

Turbine Generator and Two Surface Condensers for Hell Gate

The United Electric Light & Power Co. of New York has placed with the Westinghouse Electric & Manufacturing Co. an order for a 165,000-kw. turbine generator unit and two surface condensers with the necessary auxiliaries for circulating condensate and air removal.

The new generator unit will be built at the South Philadelphia works and installed in the Hell Gate power station at New York. The unit will be of the cross compound type and operate at a speed of 1,800 r.p.m. Steam will be supplied to the throttle at 265-lb. gage pressure, 200 deg. F. superheat and will pass into the condenser at a pressure of one inch of mercury absolute.

The two main generators for operation at a speed of 1,800 r.p.m. will each have a rating of 80,000 kw., 85 per cent power factor, producing 3-phase, 60-cycle current at a potential of 13,800 volts. An auxiliary generator rated at 5,000 kw., 80 per cent power factor, producing 3-phase, 60-cycle current at a potential of 2,400 volts, will also be furnished. Direct connected exciters will be supplied for both the main and auxiliary generators.

One condenser will serve the above generator unit, and the other condenser will serve the 160,000-kw. cross compound unit, purchased over a year ago for delivery next year.

Each of the condensers is of the two-pass design, having 137,500 sq.ft. of tube surface, and arranged to circulate 155,000 g.p.m. by two motor-driven circulating pumps. The air remover equipment for these condensers will be of the three-stage air-ejector type. These condensers will be the largest two-pass surface condensers in the world.

Students of N. Y. University To Learn Practice In Plants

A broader system of co-operative instruction is being put into operation in the College of Engineering of New York University according to Charles W. Lytle, director of Industrial Co-operation at the University. The plan involving sixteen months of outside employment in selected industrial plants during the five year course was instituted less than five years ago. In that period of time, according to Director Lytle, the merit of the plan has been demonstrated as it affects the students involved, industry and the university.

This recent innovation in teaching methods is based on the idea that a successful engineer must have practical equipment as well as a good technical background. During the past experimental period it has been amply demonstrated that the college work done by the men after returning from a period spent in industry is far superior to that done by other students.

"At the College of Engineering a student may elect an all-resident four year course leading to a bachelor's degree or a five year co-operative course leading to an engineering degree," said Professor Lytle. "The two courses do not differ until the end of the Sophomore year. Such a course may be taken in aeronautical, civil, electrical, mechanical, chemical or industrial engineering. At the end of the second year in the College of Engineering the co-operative student registers for outside employment and is placed with some company which can give him the variety of experience needed for his chosen line."

F. Feidell, Steam Engineer, Dies at Seventy-one

Frank Feidell, mechanical engineer, died at his summer home at Allentown, N. J., after a short illness. He was seventy-one years old. He was born in Allentown and was a graduate of Stevens Institute of Technology in the class of '77. In 1921 the institute conferred upon him the degree of Doctor of Engineering.

For forty years he was New York agent for the Harrison Safety Boiler Works, which afterward merged with the Cochrane Corp. of Philadelphia. Mr. Feidell was a member of the Association of Mechanical Engineers, the Engineers Club, the University of Brooklyn, the Brooklyn Chamber of Commerce and the Delta Tau Delta fraternity. His city home was at 178 Bainbridge Street, Brooklyn.

Brooklyn Polytechnic Offers Thorough Oil Engine Course

Systematic instruction is being offered by the Polytechnic Institute of Brooklyn on Diesel and oil engines, a course dealing with the fundamentals that underlie the use and construction of oil engines.

Twenty two-hour lectures are given during the winter every Friday evening at 7:30, beginning October 7 and ending with the delivery of the twentieth lecture.

To meet the needs of those who wish to train themselves for operating, building, selling or designing oil engines the lecture course is supplemented by classroom exercises and laboratory periods. Several varieties of oil engines are available in the laboratory for demonstration and testing.

Students enrolling for this work will meet every Tuesday evening, alternating each week between laboratory periods, and classroom work consisting of oral discussion and written tests.

Those students who enroll for the classroom and laboratory work in addition to the lectures and whose attendance, ratings in the tests, and general proficiency warrant it, will be given a certificate at the end of the course attesting the fact that they have attended and that they have satisfactorily pursued the course of study on Diesel and Oil Engines.

Subject Matter and Methods

The economies of power produced by oil engines will be treated, and special emphasis will be laid on operation and maintenance. The scientific and mathematical aspects of oil engine construction will be developed with a view to making the operator able to think for himself and will advance far enough to prepare those students who wish it for manufacturing and designing work.

Direct supervision of the course is in the hands of Prof. E. F. Church, Jr., head of the Department of Mechanical Engineering. The lectures are prepared and delivered by Edgar J. Kates, consulting engineer and chairman of the Oil and Gas Power Division, American Society of Mechanical Engineers. Professor W. J. Moore, in charge of the engineering laboratory work at the Poltytechnic Institute, will personally conduct the laboratory exercises and demonstrations. Assistant Professor F. D. Carvin of the Institute will conduct the classroom discussions and tests.

Mexico Plans Extensive Power and Light Development

Electric light and power development in Mexico is progressing on a large scale, according to the first bulletin issued by the Pan-American Information Service, of New York.

The Mexican Light & Power Co., Ltd., the bulletin announces, has recently undertaken a large program of construction for the purpose of increasing the power supply of Mexico. The company is spending approximately $14,000,000 in overhauling existing plants and distribution systems and developing new lines.

Bridge River, To Develop 600,000 Horsepower

During October the British Columbia Electric Railway Company, Ltd., of Vancouver, B. C., will start operations covering the construction of the Bridge River tunnel. This is the first of the major construction items to be carried out in connection with the development of the Bridge River hydro-electric project.

The Bridge River project is located about 135 miles northeast of Vancouver. The initial development will consist of two 30,000-hp. double, overhung, impulse wheels, operating under 1,200-ft. head and direct connected to 20,000-kw. generators. The ultimate development, with full regulation of Bridge River, will call for an installed capacity of some 600,000 hp., all in one power house.

The power will be transmitted to a connection with the system of the British Columbia Electric Railway Company, Ltd., at Vancouver, over a transmission line 135 miles in length. For the initial installation the voltage will be in the neighborhood of 165,000 volts. The ultimate transmission voltage will be 220,000 volts.

It is planned to complete the tunnel and also to have the plant in operation by the end of 1930.

Bureau of Standards Launches Study of Refractories

Through work now in progress, the Bureau of Standards aims at greatly increasing the life of refractories used in construction of coal-fired boiler furnace walls. It has been necessary, first of all, to determine what takes place in the formation of slag. The reactions are complex and influenced by many factors such as the composition of the refractory and its physical structure, the composition of the slag, velocity of the furnace gases, the temperature, etc.

Petrographic Examination Made

A laboratory study of this problem was undertaken some time ago at the Columbus Branch of the Bureau of Mines (now under the Bureau of Standards) in co-operation with a special research committee on boiler furnace refractories of the American Society of Mechanical Engineers and the Fuel Division of the Bureau of Mines. At the Columbus branch petrographic examinations are being made of the slags and refractories from tested boilers with the hope that a knowledge of the crystalline constituents of the slag and the associated refractory material may be correlated with the service behavior of the refractory.

Results of preliminary observations of some slags and refractories, based on a microscopic study of the effect of slags in two furnaces, one burning Illinois coal and the other "Pittsburgh" from Belmont and Jefferson Counties, Ohio, show that a mineralogical relation exists between the slag and the refractory used.

Cooled Slag Constituents

The principal phases present in a cooled slag are: (1) a plagioclase fledspar, (2) magnetite or hematite, (3) mullite with iron oxide in solid solution, (4) glass. The so-called "interface" between slag and refractory is largely crystalline upon cooling and consists principally of mullite which, surrounded by the slag, has grown from fine needles in the refractory to larger ones. In high alumina refractories where diaspore is present the stained interface is much thicker and grains of corundum are formed. This zone of crystallization may be conducive to spalling.

Chelan Power Plant Ready for Operation

Current from the first unit of the Chelan hydro-electric project of the Washington Water Power Co. of Chelan, Wash., which it is claimed, when all four generating units are installed, will be larger than any other electric generating station now existing in the Pacific Northwest, was recently turned into the transmission system of the company.

Water was turned into the tunnel slowly September 1 and has been running in gradually since, permitting a general try-out of the entire system before the power stored behind the dam is converted into electric energy for commercial purposes. As soon as this is accomplished the present 110,000-volt transmission line from Chelan to Coulee and on to the eastern portion of the state will carry power from the first generating unit, and much of the power also will be transmitted north to the Okanogan Valley district over the present 60,000-volt line. Other lines will be extended from the station as additional units are installed.

Charleston, S. C., Gets More Power

First tests with the new 10,000-kw. addition to the power plant of the South Carolina Power Co. at Charleston have been successfully made, and it is expected that within a few days the city will be regularly supplied by the new plant.

Eight Diesel Contracts for Shipping Board Vessels

Contracts for the construction of eight Diesel engines for installation in Shipping Board cargo vessels have been awarded, as was announced Sept. 19 by T. V. O'Connor, chairman of the Board.

Four different companies bid successfully. The time that will be required for completion of the engines will be aproximately 185 days.

The ships to be converted to motor ships under this program have not been selected, but action to this end will be taken at some time prior to completion of the engines. The contracts which have been awarded are as follows:

With the Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., for two 3,950-b.hp., two-stroke-cycle, single-acting internal-combustion engines, with two Elliot scavenging blowers, for the price of $584,600 for both engines; the Hooven, Owens, Rentschler Co. of Hamilton, Ohio, for two 4,000-b.hp., two-stroke-cycle, double-acting internal-combustion engines, with two American Brown Boveri Corp. scavenging blowers, for the price of $592,000 for both engines; McIntosh & Seymour Corp of Auburn, N. Y., for two 3,900-b.hp., four-stroke-cycle, double-acting internal-combustion engines, for the price of $577,200 for both engines, and with the Worthington Pump & Machinery Corp., New York City, for two 3,625-b.hp., two-stroke-cycle, double-acting internal-combustion engines, with two Elliot scavenging blowers, for the price of $536,500 for both engines.

Contracts for Ten Billion Feet of Gas

What may be considered as an important industrial step is reflected in the announcement of the signing of a contract by the Public Service Corp. of New Jersey for the purchase of a minimum of ten billion feet of gas during the next ten years from International Combustion Engineering Corp's new low-temperature coal-carbonization plant to be erected at New Brunswick, N. J.

This plant is the first International Combustion Engineering construction of the kind in this country, the process having been in successful commercial operation for several years at Essen, Germany, where much coal has been distilled and the products marketed.

Plans call for the handling of approximately 250,000 tons of bituminous slack coal a year through the initial installation of the eight units. In addition to the gas, which is a byproduct, the plant will produce six million gallons of coal tar yearly, which has all been contracted for by the F. J. Lewis Manufacturing Co., of Chicago; 1,250,000 gal. of crude motor spirits, which is said to be higher in power than the present blended gasoline.

Rumor Unconfirmed

A news item appeared in the July 19 issue of *Power* to the effect that "A public owned and operated hydro-electric system is under way in the State of Washington and contemplates projecting lines throughout the state, including the territory of the Puget Sound Power & Light Co., the Washington Water Power Co. and the Pacific Power & Light Co."

The accuracy of this statement was questioned as a result of which inquiry was made through our correspondent in that section, who furnished the information originally. This inquiry fails to confirm the earlier rumor in the sense of anything having actually materialized.

Obituary

LT. COLONEL J. C. JURGENSEN, mechanical engineer for a number of years associated with the United Piece Dye Works, following a long illness, died at his home at Rapidan, Va., July 25. Some years ago Lt. Colonel Jurgensen took the leading interest in the founding of the Institute of Operating Engineers, but due largely to the interruption of the War and a multiplicity of duties his plans did not materialize. For a considerable period he was engaged in power plant work for the Hotel Ritz Carlton, New York. His connection with the Union Piece Dye Works terminated when he enlisted his services during the war, through which he received his grade of lieutenant colonel.

THOMAS B. DAVIS, president of the Moline Water Power Co., Ill., and founder of electric utilities plants in the district of Rock Island, died Sept. 20, at the age of 71 years. In association with his brother, Samuel S. Davis, he organized the Moline Waterworks Co. in 1883. In 1906 an Eastern syndicate acquired the utility interests of Mr. Davis at Davenport, Iowa, now known as the Peoples Light & Power Co., controlled by the United Light & Power Co.

Personal Mention

R. C. NEWHOUSE has joined the mechanical engineering staff of the Allis Chalmers Manufacturing Co., Milwaukee, Wis.

W. C. KLESPE, formerly in charge of engineering at the Racine Radiator Co., is now engineer in charge of machinery design, radiator and tool layout at the manufacturing plant of the Young Radiator Co., Racine, Wis.

JOHN C. ORKNEY is now head of the electrical engineering department of the Robert Gordon's Technical College, Aberdeen, Scotland.

JAMES W. TRIMMER is now professor of mechanical engineering at the College of Industries, Carnegie Institute of Technology, Pittsburgh.

F. M. YOUNG, president of the Young Radiator Co., Racine, Wis., makers of high-grade radiators, cooling systems and heating units, has announced the appointment of John J. Hilt as sales manager.

ERIC H. EWERTZ, past president of the American Welding Society and formerly general manager of the Bethlehem Shipbuilding Corp., has opened an office at 50 Church St., New York City, as a consulting engnieer on problems relating to welding, mechanical and economic engineering.

Business Notes

THE ST. JEROME POWER CO., LTD., Quebec, Que., has been incorporated to carry on business as a light, heat, power and water-works company.

The BAILEY METER CO., Cleveland, recently moved its main office and the manufacturing plant into its new quarters at 1036 Ivanhoe Road.

CHICAGO PNEUMATIC TOOL CO., 6 East 44th St., New York City, announces the appointment of J. C. Fitzpatrick as district manager of sales at 1241 East 49th St., Cleveland, succeeding J. L. Westenhaver who has resigned to enter into business for himself.

CONNERY & CO., steel plate construction, Second Street above Erie Avenue, Philadelphia, have now in operation the recently completed extension to the company's manufacturing plant at Second and Luzerne Streets. The new building, of the latest design and fire-proof construction, has materially increased the company's production capacity for the manufacture and erection of breechings, uptakes, air and preheater ducts constructed with Connery's improved expansion stiffener.

THE ALEXANDER MILBURN CO., 1416-1428 West Baltimore St., Baltimore, Md., manufacturer of welding and cutting apparatus, portable carbide lights, oil burners and preheaters, and paint and lacquer spraying equipment has organized an office in Boston to be known as THE ALEXANDER MILBURN SALES CO., Wiggin Terminals Building, 50 Terminal St. This office is under the supervision of M. B. Crouse and G. B. Malone, who will handle the sale and distribution of Milburn equipment throughout the New England States.

THE WADE ENGINEERING CO., Los Angeles, handling Lincoln Electric products, has relocated its northern office at 533 Market St., San Francisco.

MCCLAVE-BROOKS CO., manufacturer of McClave combustion systems, Scranton, Pa., is now represented in Canada through three branch offices of the Moss Engineering Co., Ltd., at Windsor, Ont., care of Larkin & Rigney, 30 London St., West; Toronto, Ont., Empire Bldg., 64 Wellington St., West, and at Montreal, Que., care of A. Balmfirth, 334 Craig St., West.

THE KENNEDY VALVE MANUFACTURING CO., Elmira, N. Y., announces the appointment of R. J. Flanagan as manager of its Chicago sales office and warehouse. Mr. Flanagan has been connected with the company for a number of years, both in the plant at Elmira and in the sales department. His previous position as Elmira district representative is being taken by J. T. Connelly, who has been transferred to Elmira from the Cleveland sales office.

Trade Catalogs

TURBINES FOR MECHANICAL DRIVE—Leaflet 3907-C, of the Westinghouse Electric & Manufacturing Co., describes turbines for mechanical drive in capacities 5 to 750 brake horsepower. They are suited for driving circulating pumps, centrifugal boiler-feed pumps, blowers and other rotary apparatus either directly or through the medium of reduction gears. The leaflet contains a number of illustrations together with descriptive information of the turbines.

C-E FIN FURNACES—The Combustion Engineering Corp., 200 Madison Ave., New York City, has issued catalog FF-2 describing water-cooled furnaces designed to eliminate wall maintenance and increase boiler capacity. This new edition has been completely revised, and numerous illustrations, including setting drawings and plant layouts, have been added. These drawings exemplify the most modern trends in boiler and furnace design. This catalog will be sent upon request.

SILENT HOIST WINCHES, CRANES AND DERRICKS—The Silent Hoist Winch & Crane Co., 762-772 Henry St., Brooklyn, N. Y., has issued new Bulletin No. 30 featuring all the different types and sizes of the complete line of Silent Hoist motor truck and power winches. Also the partial list of users of Silent Hoist truck winches, cranes and derricks, a list representative of the most prominent public utilities, industrial firms and contractors throughout the country, is given. Copies will be sent on request.

OPTICAL PYROMETERS — A pamphlet published by the Pyrometer Instrument Co., 74 Reade St., New York City, describes a new self-contained optical pyrometer. Its principle of operation is explained and detailed instruction for its use is given.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Society of Civil Engineers, fall meeting at Columbus, Ohio, Oct. 12-15; meeting headquarters will be at the Neil House; address F. H. Waring, Chief Engineer, State Department of Health, Columbus, Ohio.

American Society of Heating & Ventilating Engineers, hold general meeting in New York City, during 4th week in January; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Refrigerating Engineers, annual convention in New York, Dec. 5-7; W. H. Ross, sec., 37 W. 39th St., New York City.

American Water Works Association. California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Southwest Waterworks Association will meet at Hot Springs, Ark., Oct. 10; Lewis A. Quigley, sec., superintendent of City Waterworks, Fort Worth, Tex. Section, at Council Bluffs, Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 179 Brodway, New York City.

American Socity of Mechanical Engineers, convention during week of New York Power Show, New York City, Dec. 5-10; Calvin Rice, sec., 29 West 39th St., New York City.

Empire State Gas and Electric Association, meeting at Lakeside Club House, Lake Placid, N. Y.; Oct. 6-7; C. H. B. Chapin, sec., Grand Central Terminal, New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held at the Hotel Statler, St. Louis, Mo., Oct. 10-13. Address inquiries to William G. Christy, Citizens' Smoke Abatement League, Chamber of Commerce Bldg., St. Louis, Mo.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

ELECTRICITY SAVING DEVICE—"Edmoore" Power Demand Limitator, a Patented Product, is the heading on Bulletin No. 11, published by Edward T. Moore, manufacturer, 500 Cahill Bldg., Syracuse, N. Y. The "Limitator" is an electrical device for automatically controlling and limiting the power demands or peak loads on electric power systems for consumers. It is claimed that by its use many small plants are saving large sums every month. The device is generally connected to the main incoming power lines of a consumer's plant so as to summate all power. The bulletin is profusly illustrated.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Sept. 21 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.56
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.70@ 1.90
Kanawha	Columbus	1.50@ 1.75
Hocking	Columbus	1.75@ 2.00
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.35@ 1.60
Franklin, Ill.	Chicago	
Central, Ill.	Chicago	
Ind. 4th Vein	Chicago	
West Ky.	Louisville	2.00@ 2.25
S. E. Ky.	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.75@ 2.00
Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	3.00@ 3.50
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.50@ 1.80

FUEL OIL

New York—Sept. 29, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Sept. 21, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 30@32 deg., $1.75 per bbl.; 32@36 deg., gas oil, 4.401c. per gal.; 38@40 deg., 5.105c. per gal.

Pittsburgh—Sept. 20, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—Sept. 22, 26 x 30 deg., $2@$2.06 per bbl.; 13@19 deg., $1.68@ $1.74 per bbl.; 22 plus, $1.79@$1.85; 27@30, $2.10@$2.16.

Cincinnati—Sept. 20, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

Chicago—Sept. 24, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 24@26 deg., 87½c. per bbl.; 26@30 deg., 90c.; 30@32 deg., $1.00.

Boston—Sept. 26, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5.85c. per gal.

Dallas—Sept. 24, f.o.b. local refiners, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Ala., Andalusia — Andalusia Light & Power Co. plans the construction of a steam operated electric power plant, 66,000 kw. daily capacity. Estimated cost $85,000. This corrects report noted under Louisiana, Sept. 6 issue.

Calif., Hollywood—T. H. Miller, c/o Group headed by R. Neutra, 835 Kings Rd., Archts., awarded contract for a 13 story apartment building including boiler rooms, etc. at Franklin and Argyle Aves. to State Construction Co., 707 Financial Center Bldg., Los Angeles, $1,006,000.

Calif., Los Angeles—Community Laundry, C. C. Craig, Pres., is having plans prepared for the construction of a laundry and boiler room at Highland and Willoughby Aves. Estimated cost $100,000. W. J. Saunders, 227 Laughlin Bldg., is architect.

Calif., Pasadena—First Trust & Savings Bank and First National Bank, are receiving bids for a 9 story bank and office building at Colorado and Madison Aves. Bennett & Haskell, Security Bldg., are architects.

Conn., New Haven—United Illuminating Co., 84 Temple St., awarded contract for foundation of a power plant on Grand Ave., to The Foundation Co., 120 Liberty St., New York. Estimated total cost $3,000,000.

Ill., Chicago—High Noon Club of Chicago, C. E. Knapp, Pres., plans the construction of a 44 story office and club building. W. W. Ahlschlager, Inc., 65 East Huron St., is architect.

Ill., Chicago—P. F. Reynolds, 8 South Dearborn St., is having plans prepared f r a 12 story apartment at 1500 Lake Shore Dr. Estimated cost $2,000,000. McNally & Quinn, 8 South La Salle St., are architects.

Ill., Evanston—H. S. Jones, 1428 Noyes St., is having plans prepared for a 7 story apartment at Hinman Ave. and Grove St. Estimated cost $1,100,000. Hall, Lawrence, Rippel & Ratcliffe, 123 West Madison St., are architects.

Ind., Indianapolis—Methodist Hospital, 18th St. and Capitol Ave. will receive bids until Oct. 15 for the construction of a 7 story hospital and nurses home including elevators, etc. Estimated cost $500,000. D. A. Bohlen & Son, 1001 Majestic Bldg., are architects.

Ia., Iowa City—State Bd. of Education, W. H. Gammill, Secy., State House, Des Moines, awarded contract for addition to heating plant for college to Preister Construction Co., 910 Kahl Bldg., Davenport. Estimated cost $40,341.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., will soon award contract for the construction of a substation at 31-33 Hawkins St. Bigelow & Wadsworth, 120 Tremont St. are architects.

Mich., Birmingham—James Couzens, is having plans prepared for an 8 story office building including steam heating system, boilers, elevators, etc. on Maple Rd. Estimated cost $1,000,000. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mich., Fordson—J. Schaefer, awarded contract for a 4 story apartment on Michigan Ave to Blair Construction Co., 3212 Book Tower, Detroit. Estimated cost $1,000,000. Steam heating system, boilers, elevators, etc. will be installed.

Mich., Mt. Clemens—City voted $640,000 bonds for a complete waterworks system including filtration plant and pumping station, etc. B. H. Harvey, City Hall, is engineer.

Miss., Howell—State Hospital Removal Improvement and Land Sale Comn., R. L. Brown, Secy., Jackson, will receive bids until Oct. 5 for addition to hospital including power plant, etc. Estimated cost $500,000. N. W. Overstreet, Mississippi Fire Bldg., Jackson, is architect.

Miss., Water Valley—City will soon award contract for water and light plant improvements including power plant equipment, etc. T. H. Allen, Bank of Commerce Bldg., Memphis, Tenn., is engineer.

Mo., Clinton—Missouri Public Service Co., c/o Inland Power & Light Corp., 411 North 7th St., St. Louis, will soon receive bids for addition to power plant. Estimated cost $400,000. Private plans.

Mo., Kennett—City plans the construction of a power plant. Estimated cost $25,000.

Mo., St. Louis—Hotel Jefferson Co., L. T. Hay, Pres., awarded contract for a 14 story addition to hotel at Locust Blvd., St. Charles St. and Twelfth Blvd. to Boaz-Kiel Construction Co., Ambassador Bldg. Estimated cost $2,000,000.

N. H., Epping—City awarded contract for waterworks improvements including pumping station, etc. to Ames Construction Co., Somersworth. Estimated cost $30,000.

N. Y., Brooklyn—Halsey, McCormack & Helmer, 286 5th Ave., New York, Archts., will receive bids until Oct. 11 for the construction of a 40 story bank and office building including steam heating and ventilation systems, boilers, pumps, elevators, etc. at Hanson and Ashland Pls., here for Williamsburg Savings Bank. Estimated cost $4,000,000. F. Sutton, 140 Cedar St., New York, is engineer.

N. Y., New York—Hispanic Society of America, 620 West 156th St., awarded contract for addition to boiler house, etc. to Marc Eidlitz & Sons, 41 East 42nd St. Estimated cost $150,000.

N. Y., New York—Julius Tishman & Sons, 285 Madison Ave., are having plans prepared for a 14 story apartment building including steam heating and ventilation systems, boilers, elevators, etc. at Park Ave. and 81st. St. Estimated cost $3,000,000. Schwartz & Gross, 347 5th Ave., are architects.

N. Y., New York—Six West Seventy Seventh St. Corp., is having plans prepared for a 15 story apartment including steam heating and refrigeration systems, boilers, pumps, elevators, etc. at 6 West 77th St. Estimated cost $2,000,000. N. Korn, 9 East 40th St., is architect.

N. Y., New York—Tillion & Tillion, 415 Lexington Ave., Archt., will receive bids until Oct. 6 for a 25 story church and hotel, including steam heating, refrigeration and ventilation systems, boilers, pumps, elevators, etc., at Broadway and 76th St. for Twenty-One Sixty-Six Broadway Corp. Estimated cost $2,000,000.

Okla., Wagoner—City voted $57,000 bonds for the construction of an electric light plant.

Pa., Erie—Joseph Zurn, plans the construction of a plant including boiler house, etc. Wilbur Watson & Associates, 4614 Prospect Ave., are architects and engineers.

Pa., Pittsburgh—A. W. Mellon & J. E. Weston, Raskin Apartments, will build a 22 story hotel at Diamond St. and Cherry Way. Estimated cost $2,000,000. H. L. Stevens & Co., 522 5th Ave., New York, N. Y., are architects. Work will be done by separate contracts.

R. I., Providence—Bd. of Contract & Supply, awarded contract for the construction of a pumping station on Bath St. to P. J. Flynn, 17 Exchange St. Estimated cost $30,000.

Tex., Jasper—Gibbs & Co., is having plans prepared for addition to ice and cold storage plant. Estimated cost $16,000. Private plans.

Tex., Marshall—City, H. J. Graeser, Mgr., is having surveys made for waterworks improvements including pumping equipment, mains, etc. Estimated cost $50,000.

Tex., Dallas—Southwestern Bell Telephone Co., 11th and Pine Sts., St. Louis, Mo., awarded contract for a 14 story office building at Akard and Wood Sts. here, to Henger & Chambers, 1600 Dallas National Bank Bldg., Dallas, Tex. Estimated cost $2,500,000.

Tex., Pyote—Arctic Ice Co., H. M. Price, Pyote, Tex., will soon receive bids for the construction of an ice and cold storage plant. Estimated cost $60,000.

Ont., Niagara Falls—United Hotels of America G. O'Neil, Gen. Mgr., King Edward Hotel, Toronto, will receive bids about Oct. 15 for a 10 story addition to hotel including steam heating system, elevators, etc. on River Rd. Estimated cost $1,000,000. Eisenwehr & Johnston, 781 Ellicott Sq., Buffalo, are architects.

T. H., Pearl Harbor—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 23 for the construction of a boiler house, etc., at Naval Operating Base (Submarine Base), here.

Equipment Wanted

Boilers and Other Equipment—Dept. of Public Works, Bureau of Water, Pittsburgh, Pa., will receive bids about Jan., 1928, for renewing steam boilers and other equipment at Mission pumping station.

Electric Hoists, etc. — Page L'Hote Co. Ltd., Carondelet Bldg., New Orleans, La., is in the market for electric hoists and all necessary equipment for proposed wharf improvements at Point Isabel, Tex.

Engines, Etc. — City of Mountain Lake, Minn., will receive bids until Oct. 11 for two 250 hp. Diesel engines, direct connected to 200 kw., 60 cycle, 2,300 v., a.c. generators and exciters.

Engines, Etc.—City of Ft. Smith, Ark., will receive bids until Oct. 17 for an 8,000,000 g.p.d. high lift condensing turbo-centrifugal pumping engine with surface condenser, vacuum pump, condensate pump, etc., also an 8,000,000 g.p.d. low lift condensing turbo-centrifugal pumping engine.

Generating Equipment, Switchboard, Etc.—G. Sticha, Clk., New Prague, Minn., will receive bids until Oct. 7 for new generating equipment, switchboard, etc. for proposed improvements to electric power plant. Estimated cost $40,000.

Generator Sets, Transformers, Switchboards, Etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the installation of 800 kw. motor generator sets, 100 kva. power transformers, switchboards, etc. at Navy Yard, Puget Sound, Wash.

Motor Generator Sets, Switchboard, etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the installation of motor generator sets, switchboard, etc., in Navy Yard, Brooklyn, N. Y.

Pumping Equipment—Bd. of Awards, Baltimore, Md., will receive bids until Oct. 5 for pumping equipment for Montebello pumping station.

Pumping Equipment, Etc.—City of Moberly, Mo., is receiving new bids for pumping equipment, etc., for proposed sewage disposal plant. Former bids rejected.

Pumping Equipment—City of Parkersburg, W. Va., will receive bids until Oct. 26 for furnishing and installing pumping equipment, etc., for proposed waterworks.

Pumping Unit—F. L. & B. W. Hinkly, San Benito, Tex., are receiving bids for a pumping unit for proposed waterworks improvements in residential sub-division. Estimated cost $25,000.

Pump and Motor — City of Marshall, Okla., will be in the market for a triplex pump and motor for proposed waterworks improvements. Estimated cost $25,000.

Pumps—City of Lancaster, Pa., will be in the market for three 1,000 g.p.m. sewage pumps for proposed sewage treatment plant and pumping station. Estimated cost $900,000.

Pumps—Jackson & Lehrer, Garwood, Tex., plans to purchase and install three 45,000 g.p.m. centrifugal pumps direct connected to 900 hp., 2,300 v., 450 r.p.m. motors for rice irrigation project now under construction. Esitmated cost $30,000.

Pumps, etc.—City of Pittsburg, Calif., will be in the market for two 350 g.p.m. sewage pumps, etc., for proposed sewage treatment plant.

Stoker Equipment — G. Ralihan, Clk., Albion, Ind., will receive bids until Oct. 18 for complete stoker equipment, blower, air heaters and appliances for municipal light plant.